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Reconstructing intra-site patterns in Neolithic lakeshore settlements: the state of archaeobotanical research and future prospects

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In the past 25 years information on the everyday life of Neolithic man has been expanded substantially. At least for some time spans and regions, we have rather precise knowledge of what was cultivated and gathered. But what other information have we gained? Information about intra-site patterns is of particular interest. Only when such patterns are known is it possible to interpret differences between settlements. However, to date, we have only limited information on intra-site patterns. Although many rescue excavations were carried out in Switzerland, only a few settlements have been investigated in a representative manner. In addition, there are some regions for which information is fragmentary. Statistically usable data are not available for almost half of the 86 settlements investigated since the 1960s. This article outlines available results concerning intra-site patterns, and discusses the sampling strategies that should be used for obtaining statistically reliable data. We suggest that a standardised procedure for sieving and quantifying the data should be followed in future.

Keywords: lake dwellings, palaeobotany, methods, intra-site patterns, Neolithic period

1. Introduction and aims

In Neolithic (and Bronze age) lakeshore settlements, horizontal cultural (settlement) layers are preserved («Kulturschicht»; e.g. Stöckli et al. 1995; Schlichtherle 1997; Schibler, Jacomet & Choyke 2004; Menotti 2004). The sediments are waterlogged and of varying thickness. Often, complex sequences of several settlement phases exist at a single location (as an example see Twann, Orcel 1980, 17). The dating of the settlement phases is based on dendrochronology (Stöckli et al. 1995). Therefore, the exact age of houses and settlements is often known, and it is possible to define very short settlement phases of less than 20 years' duration.

Due to waterlogging, organic materials in the settlement layers are very well preserved in a subfossil (uncarbonised) state (Jacomet & Kreuz 1999, 57–59). They consist mainly of diverse types of biological remains (as a recent example see Jacomet, Leuzinger & Schibler 2004a). For the most part, it is not possible to collect these remains individually: there are too many and usually also they are too small. It is necessary therefore to take samples that are representative of the ancient situation at the site. The samples should make it possible to draw inferences relevant to nutrition, agricultural practices, gathering, fishing and hunting other smaller animals, foddering, use of wood and finally the environment in which animals and humans moved around. In addition we would like to be informed about intra-house and intra-site patterns, the disposal of rubbish and the genesis of the layers. This amounts to far more than creating a simple species list.

While sampling, 4 points/facts have to be considered:

1. the volume of the samples should be large enough for recording the totality of the remains and diversity at the place where the sample was taken

2. the density of the sampling should be high enough to be able to reconstruct intra-site patterns

3. one should have information about the type of the sample: does it consist of material that accumulated over a longer time period or does it represent a very short-term event (like e.g. a burnt store)? and

4. the stratigraphy must be represented in such a way that a reconstruction of the genesis of the settlement layer will become possible.

As a result, only those sites can be regarded as representatively investigated where relatively large surfaces were excavated and where the horizontal patterning of the plant remains (distribution) is known. Only in this case it is possible to reconstruct the economy of a settlement. Very often, no house plans are visible during the excavation. Therefore, sampling must cover the surface in such a way that later one can distinguish between inner parts of the houses and areas in between. It becomes possible therefore to reconstruct the characteristics of the houses as well as the areas in between them. In this way, characterisation of a cultural layer becomes possible and we are able to distinguish between «special cases» and the «average case». An important prerequisite for a representative archaeobiological investigation is exact dating of the settlement layers, an assignment of single strata to settlement phases and in general an evaluation of the archaeological features and finds (artefacts).

Until now, the methods applied to the recording of small (usually <5 mm) biological remains in lakeshore settlements have been very heterogeneous. In the following we would like to show which methods are suitable for finding answers to special questions. Through a comparison of the different methods, we would like to show how an ideal method would look.

In the following we concentrate on plant macrofossils like seeds, fruits, cereal chaff etc. (these are all plant remains larger than 0,1 mm), and on Neolithic sites. However, it should be stressed that for the representation of small zoological remains like fish bones the same samples can be used. Up till now, very few methodological investigations into the required volume of the samples exist (e.g. Hüster-Plogmann 1996). The following statements are also applicable to all kinds of horizontally extensive settlement layers.

2. The history and state of research, timeframe

Archaeobiological research in the prehistoric lakeshore and mire-settlements of the northern Alpine foreland began in the 19th century (Heer 1865). Around 100 years passed before samples were taken according to the excavated features resp. contexts. During this first period of archaeobotanical research, lists of the plant remains found on a site were mostly produced (for a more detailed

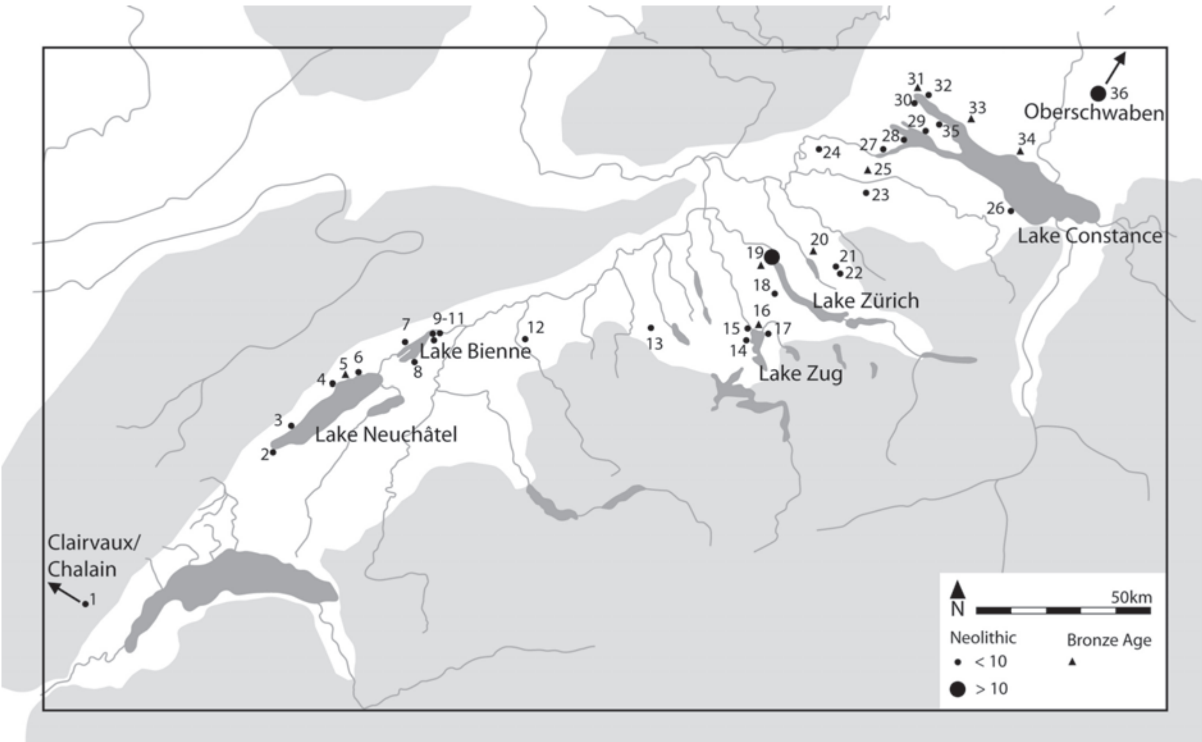
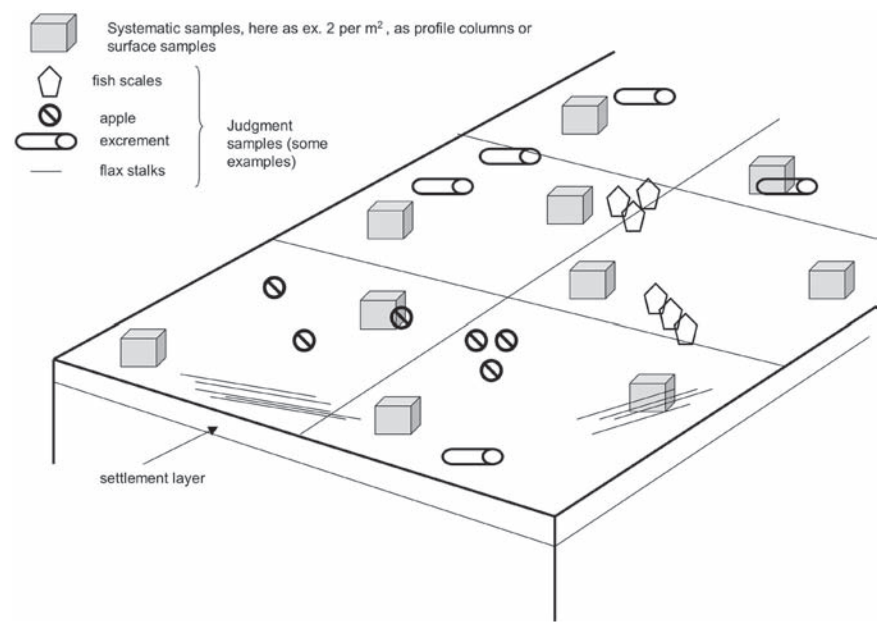


Fig. 1 Map with Neolithic and Bronze Age sites of a part of the Northern Alpine Lake Dwelling area (mainly Switzerland). Settlement layers with archaeobotanical investigations are marked with points (Neolithic sites; small points = under 10 settlement layers investigated, large point = over 10 settlement layers investigated) or triangles (Bronze Age sites). Neolithic sites date between 4300 and 2400 BC cal., Bronze Age sites between 1900 and 850 BC cal. At most of the sites several settlement layers of different age were investigated. 1: different sites at the lakes Clairvaux and Chalain (French Jura); 2: Yverdon, Avenue des Sports; 3: Concise-Sous-Colachoz; 4: Auvernier; 5: Hauterive-Champréveyres; 6: St. Blaise; 7: Twann; 8: Lüscherz; 9: Lattrigen (inkl. Sutz); 10: Port; 11: Nidau BKW; 12: Burgäschisee-Süd; 13: Egolzwil; 14: Risch-Oberrisch; 15: Cham (Eslen, St. Andreas); 16: Zug-Sumpf; 17: Zug-Vorstadt; 18: Horgen; 19: Zürich; 20: Greifensee-Böschen; 21: Pfäffikon-Burg; 22: Robenhausen; 23: Gachnang-Niederwil; 24: Thayngen-Weier; 25: Uerschhausen-Horn; 26: Arbon-Bleiche 3; 27: Wangen; 28: Hornstaad; 29: Allensbach; 30: Bodman; 31: Bodman-Schachen; 32: Sipplingen; 33: Unteruhldingen; 34: Hagnau-Burg; 35: Wallhausen; 36: several sites in the region of Federsee/Oberschwaben (Alleshausen, Oedenahlen, Reute, Stockwiesen, Torwiesen, Aichbühl, Riedschachen, Wasserburg Buchau etc.). For more details of the exact dates of the sites and layers see the literature citations in the text, Schlichtherle 1997 and also Table 1. Map C. Schucany, based on informations of S. Jacomet.

Fig. 2 Sample types. Systematic sampling is possible with the help of profile columns (e.g. plastic tubes) or surface samples. Scheme S. Jacomet.



overview of the history of this research, see Jacomet & Kreuz [a]). From the 1960s onwards, the situation improved. The first investigations with suitable sampling were carried out at Seeberg Burgäschisee Süd in Switzerland (Villaret-von Rochow 1967) and Ehrenstein in Southern Germany (Hopf 1968; in fact there were more, but others like Gachnang-Niederwil were only published much later; Waterbolk & van Zeist 1991). In these cases, mainly subjective samples were taken, such as visible concentrations of carbonised cereals. Really quantifiable data, including also systematically taken samples, were produced only from the 1980s onwards (Jacomet 1981; Schlichtherle 1985; Jacomet et al. 1989). Only from this point onwards sites have been investigated in a representative way (e.g. Hornstaad-Hörnle IA: Maier 2001; or Arbon Bleiche 3: Jacomet, Leuzinger & Schibler 2004a). In the following we consider only those sites where we have information about the sampling strategy, the volume of the samples and the number of plant remains found. Literature compilations with older data like Hopf & Blankenhorn 1983–84 and Hofmann 1983–84 (both publ. 1986) were not considered.

In order to evaluate the methods that were applied until now, we compiled the data from 86 settlement layers in the northern Alpine foreland where archaeobotanical investigations have been carried out (table 1). We considered only those sites that are datable as precisely as possible. 36 are sites of the first phases of the Late Neolithic (the so called Jungneolithikum, 4380–3500 BC), while another 36 can be dated between 3500–2750 BC (Spätneolithikum) and 14 represent the final phases of the Neolithic (after 2750 BC). The location of the sites is shown on Fig. 1; the easternmost settlements lie in Bavaria, the westernmost in the French Jura. For an overview see also Jacomet [a] and [b].

3. Methods

In table 1 we compiled all the information that is needed in order to evaluate the representativeness of the data. Several aspects of sampling were not described in the publications and therefore remain unclear (marked by «k.A.» or «?»).

Where possible, we compiled the data according to settlement phases. Thus, one site may show up several times in our list because several layers or settlement phases were found there. Information about the dating of the settlement phases was taken from the archaeobotanical or archaeological literature (for Swiss sites mainly from SPM II; Stöckli et al. 1995). In cases where layers had been re-evaluated after the initial archaeobotanical work the dating was changed accordingly (as, for example, in the case of Yverdon, Avenue des Sports, after Wolf 1993). In this case it was necessary to re-order the samples chronologically. The dates in table 1 are mainly dendrochronological dates.

We compiled as a next step several methodological criteria for evaluating the quality of an investigation. An important criterion is for example the smallest sieve mesh size, which should be 0.5 mm maximum for the recording of economically important taxa such as the small seeds of opium poppy. Also important is the consideration of different sample types (see Jacomet et al. 1989, 36–39, and Fig. 2). It is important to investigate, on the one hand, the remains of single events (like a burnt layer or a coprolite; sample type g in table 1, normally taken as judgment samples). On the other hand, and above all, material should be investigated which was deposited continuously over a longer time period (sample type o in tab. 1). Sample type plays a decisive role when interpreting the data.

In order to reconstruct intra-site patterns, samples from many locations in a settlement layer should be analysed:

number	site	preservation	dendrodate, beginning	comment date	dendrodate end	region	country	culture	representativity	smallest sieve mesh size	type of sample	number of samples	total volumes
1	**Hornstaad (D) Hörnle IA Kr. Konstanz**	**F**	**3917**		**3905**	**BO**	**D**	**Pfyner K. (Hornstaader Gr.)**	**1**	**0.25**	**o+g**	**>5000**	**>97**
2	Sipplingen (D) Osthafen, Pfyner Schichten, Bodenseekreis	F	3700	?		BO	D	Pfyner K.	2	0.5	o (g?)	44	16
3	Ergolding (D) Fischergasse, Kr. Landshut	F(T)	3685		3360	BA	D	Altheimer K.	2	k.A.	o	38	103
4	Gachnang TG Niederwil	F	3659		3585	BO	CH	Pfyner K.	2	0.20	o+g	60	k.A.
5	Oedenahlen (D) Riedwiesen, Kr. Biberach	F	3700		3688	FO	D	Pfyn/Altheim	3	0.30	o+g	176	>33
6	Alleshausen (D) Hartöschle Kr. Biberach	F	3920		3916	FO	D	Schussenrieder K.	3(1?)	0.25	o +g	39	12
7	Ehrenstein (D) Kr. Ulm, Phasen I-III	F	3955		3948	FO	D	Schussenrieder K.	4	k.A.	g+o	67	35ca
8	Reute (D) Schorrenried Kr. Ravensburg	F	3738		3732	FO	D	Pfyn/Altheim	4	0.02	o+g	75	>8
9	Thayngen SH Weier, Sch. 16-19, Profil III	F	3822		3584	BO	CH	Pfyner K.	5	0.40	o	9	k.A.
10	Wallhausen (D) Ziegelhütte, Kr. Konstanz	F	3750	?	?	BO	D	Pfyner K.	5	k.A.	o?	3	k.A.
11	Hornstaad (D) Hörnle IB Kr. Konstanz	F	3586		3507	BO	D	Pfyner K.	5	0.25	o	10	3
1	**Risch ZG Oberrisch, Aabach,**	**F(T)**	**3710**	**?**	**?**	**MZ**	**CH**	**Pfyner K. bzw. Zürich-Seefeld**	**1**	**0.50**	**o(g)**	**54**	**668**
2	Egolzwil LU 3, Wauwiler Moos	F	4282		4275	MZ	CH	Egolzwiler K.	2	0.25	o(g)	103	82
3	Cham ZG Eslen	F	4225		4100	MZ	CH	Egolzwil/frühes zs. Cortaillod bzw. Zürich Hafner	2	0.35	o	28	20
4	Zürich Kan San Schicht 9	F	3827		3804	MZ	CH	Pfyn/Cortaillod-Üb. Bzw. Zürich Hafner	2	0.25	o+g	34	16
5	Zürich AKAD/Pressehaus, Schicht J	F	3728		3681	MZ	CH	Pfyner K. bzw. Zürich-Seefeld	2	0.25	o(g)	128	210
6	Zürich KanSan Schicht 7 (=AKAD J)	F	3719		3681	MZ	CH	Pfyner K. bzw. Zürich-Seefeld	5(2)	0.25	o+g	9	5
7	Zürich Kleiner Hafner Schichten 4A-C/D	F	4185		3950?	MZ	CH	Cortaillod, frühes zentralschweizerisches bzw. Zürich-Hafner	3	0.25	o+g	34	5
8	Zürich Kleiner Hafner Schichten 4E/F	F	3968		3831	MZ	CH	Cortaillod, klass. Zentralschweizerisches bzw. Zürich-Hafner	3	0.25	o+g	45	8
9	Zürich Mozartstrasse Schicht 5 u,o	F	3864		3834	MZ	CH	Cortaillod, klass. Zentralschweizerisches bzw. Zürich-Hafner	3	0.25	o+g	43	12
10	Zürich Mozartstrasse Schicht 4 u,m,o	F	3668		3661	MZ	CH	Pfyner K. bzw. Zürich-Seefeld	3	0.25	o+g	68	35
11	Seeberg BE Burgäschisee-Süd	F	3760		3748	MZ	CH	Cortaillod, klass. Zentralschweizerisches bzw. Zürich Hafner	4	<0.5	o+g	>130	k.A.
12	Zürich Kleiner Hafner, Schichten 5A+B	F	4384		4280	MZ	CH	Egolzwiler K.	5(3?)	0.25	o	16	6
13	Zürich Mozartstrasse Schicht 6	F	3908		3871	MZ	CH	Cortaillod, klass. Zentralschweizerisches bzw. Zürich-Hafner	5	0.25	o+g	39	14
14	Zürich Mozartstrasse Schicht 4B+4A	F	3714	?	3675	MZ	CH	Pfyner K. bzw. Zürich-Seefeld	5	0.25	o	11	8
15	Zürich KanSan Schicht 5	F	3616		3600	MZ	CH	Pfyner K. bzw. Zürich-Seefeld	5	0.25	o+g	13	5
16	Cham ZG St. Andreas	F(T)	3700	?	?	MZ	CH	Pfyn (-Cortaillod?)	5	0.50	g	4	1ca
1	Concise VD Sous Colachoz COM (EMS (Konz.))	F	3709		3701	MW	CH	Cortaillod-Moyen, Ens. 2	3(5?)	0.50	o	18	18ca
2	Clairvaux (F) V Motte Aux Magnins	F	3659		3525	JU	F	Néolithique Moyen Bourguignon récent	3	0.20	o	29	4ca
3	Port BE Stüdeli, US	F	3686		3638	MW	CH	Cortaillod, spätes	4	0.50	g	21	3.6
4	Port BE Stüdeli, OS	F	3572		3560	MW	CH	Cortaillod, spätes	4	0.50	g	26	3.3
5	Twann BE US, E1-2	F	3838		3768	MW	CH	Cortaillod classique	5(3?)	0.25	o+g	25	3ca
6	Twann BE MS (E3-4)	F	3702		3687	MW	CH	Cortaillod tardif	5	0.25	o	21	2.5ca
7	Twann BE MS (E5 - 5a)	F	3643		3607	MW	CH	Cortaillod tardif	5(3?)	0.25	o+g	21	3ca
8	Twann BE OS (6-7)	F	3596		3573	MW	CH	Cortaillod tardif	5(3?)	0.25	o+g	16	2ca
9	Concise VD Sous Colachoz COT2 (Häuf.-Klass.)	F	3567		3540	MW	CH	Cortaillod tardif	5	0.5?	k.A.	4	?
1	Pestenacker (D) Kr. Landsberg, Phasen I-III	F	3496		3446	BA	D	Altheimer K.	2?	0.35	o+g	265	8,5 (?)
2	Torwiesen II (D) Bad Buchau, Kr. Biberach	F	3282		?	FO	D	Horgener K.	4	0.25	o+g	47	21
3	Seekirch (D) Stockwiesen, Kr. Biberach	F	3030		2890	FO	D	Horgen/Goldberg III, Üb.	4	0.25	o+g	40	8
4	Alleshausen (D) Grundwiesen, Kr. Biberach	F	2916		2890	FO	D	Goldberg III	4	0.25	o+g	29	20.5
5	Seekirch (D) Achwiesen, Kr. Biberach	F	2916		2890	FO	D	Goldberg 3	5(?)	0.25	o+g	22	10.5
1	**Arbon TG Bleiche 3 Flächenproben**	**F**	**3384**		**3370**	**BO**	**CH**	**Pfyn/Horgener K.**	**1**	**0.35**	**o**	**33/73**	**185/340**
1	Arbon TG Bleiche 3 Profilproben	F	3384		3370	BO	CH	Pfyn/Horgener K.	2	0.25	o	33	7,3
2	Hornstaad (D) V südl. Pfahlfeld	F	3176		??	BO	D	Horgener K.?	2?	k.A.	o(g?)	16	11.6
3	Hornstaad (D) V nördl. Pfahlfeld Kr. Konstanz	F	3400	?	??	BO	D	Horgener K.?	2?	k.A.	o	11	4.8
4	Wangen (D) Hinterhorn Kr. Konstanz	F	3371		3115	BO	D	Horgener K.	5	0.25cf	o/g	16	8
5	Wallhausen (D) Ziegelhütte, Kr. Konstanz	F	3350		3125	BO	D	Horgener K.	5	k.A.	o?	5	k.A.
6	Sipplingen (D) Osthafen, Schicht 11 = u	F	3316		3306	BO	D	Horgener K.?	5	0.25	o	1	2
7	Sipplingen (D) Osthafen, Schicht 12-14 = u/m	F	3200	?	3060	BO	D	Horgener K.	5	0.25	o(g?)	6	10.7
8	Allensbach (D) Strandbad unt. Schicht B	F	3150	?	??	BO	D	Horgener K.	5	0.25	o	8	24
9	Sipplingen (D) Osthafen, Schicht 15 = o	F	2917		2860	BO	D	Horgener K.	5	0.25	o	7	11.2
10	Allensbach (D) Strandbad ob. Schicht C	F	2829		?	BO	D	Horgener K.	5	0.25	o(g)	10	20.2
1	**Horgen ZH Scheller 4**	**F**	**3078**		**?**	**MZ**	**CH**	**Horgener K.**	**1**	**0.25**	**o**	**21**	**20.7**
2	**Horgen ZH Scheller 3**	**F**	**3061**		**3037**	**MZ**	**CH**	**Horgener K.**	**1**	**0.25**	**o**	**41**	**38.2**
3	Zürich KanSan Schicht 4	F	3239		3201	MZ	CH	Horgener K.	2	0.25	o+g	48	22.5
4	Zürich KanSan Schicht 3	F	3179		3158	MZ	CH	Horgener K.	2	0.25	o+g	36	27
5	Pfäffikon ZH Burg	F	3100	?	3000	MZ	CH	Horgener K.	2	0.35	o	57	210
6	Zürich Mozartstrasse Schicht 3	F	3126		3098	MZ	CH	Horgener K.	3	0.25	o+g	139	68
7	Zürich KanSan Schicht 2	F	3126		3089	MZ	CH	Horgener K.	3	0.25	o+g	53	27
8	Zürich Mythenschloss Schicht 3	F	3240		um	MZ	CH	Horgener K.	5	0.25	o	10	1.2
9	Zürich KanSan Schicht 2A	F	2911	?	?	MZ	CH	Horgener K.	5	0.25	o+g	9	7.3
10	Oberrieden ZH Riet	F	3300	?		MZ	CH	Horgener K., früh	5	--	g	13	1ca
11	Zug ZG Vorstadt 26, Rössliwiese	F(T)	3050		3030	MZ	D	Horgener K.	5	1.00	g	1	2.5
1	Nidau BE Schlossmatte BKW Ib, Schicht 5	F	3406		3398	MW	CH	Lattrigen, frühes	2	0.25	o+g	27	23.5
2	Sutz BE Lattrigen, Hauptstation VII, aussen	F	3203		3139	MW	CH	Lattrigen, spätes	2	0.25	o+g	69	30
3	Sutz BE Lattrigen VI, Riedstation	F	3410		3380	MW	CH	Lattrigen, frühes	5	0.25	g	2	0.01
4	Lüscherz BE Kleine Station XV, Schn. 1-3	F	3410		3380	MW	CH	Lattrigen, frühes	5	0.25	g	5	0.05
5	Twann BE mittl. Horgener KS	F	3176		3166	MW	CH	Lattrigen, spätes	5	0.25	o+g	8	>0.1
1	**Chalain (F) station 3, Schicht VIII**	**F**	**3198**		**3149**	**JU**	**F**	**Horgen**	**1**	**0.25**	**o**	**49**	**13**
2	Chalain (F) station 19, Schichten H-K	F	3050		2980	JU	F	Clairvaux Ancien	3(5?)	0.25	o+g	10	6ca
3	Clairvaux (F) II	F	3470		3440	JU	F	Port Conty	5	0.20	o	4	0.4
4	Clairvaux (F) III, Schichten II und III (u und m)	F	2975		2950	JU	F	Clairvaux récent	5	0.20	o	12	>4.2
5	Charavines (F) Isère	F	3000		2750	AW	F	CSR	5	0.50	k.A.	viele?	k.A.
1	Zürich KanSan Schicht E (F?)	F	2718		2710	MZ	CH	Schnurkeramik	2	0.25	o+g	27	14
2	Zürich Mythenschloss Schicht 2	F	2680	??	??	MZ	CH	Schnurkeramik	2	0.25	o+g	51	29
3	St.Blaise NE Bains des Dames	F	2640		2450	MW	CH	Auvernier Cordé	2		o	50	31
4	Zürich Mozartstrasse Schicht 2	F	2625		2568	MZ	CH	Schnurkeramik	3	0.25	o+g	104	40.9
5	Zürich KanSan Schicht B/C	F	2685		2679	MZ	CH	Schnurkeramik	3(5)	0.25	o+g	26	16.5
6	Zürich KanSan Schicht A	F	2675		??	MZ	CH	Schnurkeramik	3(5)	0.25	o+g	20	11.5
7	Hegne (D) Galgenacker Kr. Konstanz	F	2672		??	BO	D	Schnurkeramik	5	k.A.	o	13	k.A.
8	Zürich AKAD/Pressehaus, Schicht C2	F	2719		2713	MZ	CH	Schnurkeramik	5	0.25	o	29	4
9	Zürich KanSan Kreuzstr. B,D (nur Getreide)	F	2718	?	??	MZ	CH	Schnurkeramik	5	0.25	o	7	5.5
10	Zürich KanSan Schicht D	F	2705		2689	MZ	CH	Schnurkeramik	5(3?)	0.25	o+g	20	14
11	Yverdon VD Avenue des Sports u (Schi 16-14, Schlichtherle-Profil)	F	2750		2730	MW	CH	Lüscherz récent	5	0.60	o	13	1.1
12	Yverdon VD Avenue des Sports m (13/14-10, Schlichtherle-Profil)	F	2730		2620	MW	CH	Auvernier Cordé, früh	5	0.60	o	18	14
13	Concise VD Sous Colachoz AUC (Häuf.-Klass.)	F	2699		2440	MW	CH	Auvernier Cordé	5	0.5cf	k.A.	19	k.A.
14	Yverdon VD Avenue des Sports o (9a-2 Schlichtherle Profil)	F	2600		2500	MW	CH	Auvernier Cordé	5	0.60	o	21	13.3

number of contexts	profile columns (number of samples per columns)	systematic surface samples	judgment samples	number of houses (H) and zones between them (G)	well preserved organic layer	burnt layer	mixed sediemnt	clay/stones	eroded layer	stocks	publication
>1000	**10P(?)**	**378**	**>4600**	**13H+many G**	**x**	**x**				**G,E,L**	**Maier 2001**
44	44P (44)			?	x?	x			x?	G	Riehl 2004
many		x?		?	Schwemmlöss					G	Küster 1989
many	1P(4)	11	45	2H+any G	x	x				G,L,S	van Zeist & Boekschoten-van Helsdingen 1991
many	5P(64)		112	ca.4	>30	>2		>30		G,L,S	Maier 1995
39		xx	xx	3H+sev. G	x					L	Maier 2004
many		x?	67	k.A.	x?	x		x		G	Hopf 1968
many	1P(15)		60	k.A. (tot. 6 H)	x?				x	G,S	Hafner 1998
2	*2P(9)*			*k.A.*	*x*	*x*				*G*	*Jörgensen 1975, Fredskild 1978*
1	*1P(3)*			*?*	*x*	*?*		*x*		*G?*	*Rösch 1990b*
1?	*1P?*			*?*	*x?*						*Maier not published*
54	**54**	**54**	**x**	**6H+22 G**	**x**	**x**			**x**	**G, L(?)**	**Jacomet, in Bearb.**
78	3P(28)	70	5	4H+sev. G	x			x			Bollinger 1994
16	1P(13)	15		?	x		x	x	x		Martinoli & Jacomet 2002 and not published
25	19P(28)		6	>4 H bzw. G	19		15				Brombacher & Jacomet 1997
74	4P(58)	70		4H+many G	50	19	18	17	5	G,L,S	Jacomet 1981; Jacomet et al.1989; Brombacher & Jacomet 1997
8	1P(2)		7	?	6	2	1			G	Brombacher & Jacomet 1997
22	4P(16)	2	16	?	x	x	x			G	Jacomet et al. 1989; Brombacher & Jacomet 1997
35	3P(17)	6	26	?	x	x	x	x		G	Jacomet et al. 1989; Brombacher & Jacomet 1997
31	4P(16)		27	ca 2H+2G?	19		24				Jacomet et al. 1989; Brombacher & Jacomet 1997
24	7P(51)		17	ca 4H+sev. G	36	4	23	5			Brombacher & Jacomet 1997
many	1P(?)	5(?)	127	k.A.	x	x?					Villaret-von Rochow 1967
5	*3P(14)*	*2*		*?*	*5*		*4*		*7*		*Jacomet et al. 1989; Brombacher & Jacomet 1997*
14	*4P(29)*		*10*	*?*	*3*	*1*	*31*	*4*			*Jacomet et al. 1989; Brombacher & Jacomet 1997*
4	*4P(11)*			*?*					*11*		*Brombacher & Jacomet 1997*
10	*2P(5)*		*8*	*?*	*7*		*6*				*Brombacher & Jacomet 1997*
4			*4*	*?*		*x*			*x*	*G*	*Jacomet 1986*
5		18 from 5 places		ca 2H?	x		?				Märkle 2000; Karg & Märkle 2002
23	4P(10)		19	k.A.	x			x		S?	Lundstrom-Baudais 1989
21			21	?	x?	x				G	Brombacher & Jacomet 2003
26			26	?	x?	x				G,E,L	Brombacher & Jacomet 2003
7	*2P(20)*	*2*	*3*	*?*	*x*	*x*				*G*	*Ammann et al. 1981*
5	*2P(18)*	*3*		*?*	*x*		*x*	*x*	*x*		*Ammann et al. 1981*
17	*1P(5)*	*5*	*11*	*?*	*x*	*x*		*x*	*x*	*G,E*	*Ammann et al. 1981*
9	*2P(9)*	*5*	*2*	*?*	*x*	*x*		*x*		*G*	*Ammann et al. 1981*
n.i.	*?*			*?*	*k.A.*						*Karg & Märkle 2002*
many?	x	xxx	xxx	ca. 5 H	x			x			Neef 1990, Bittmann manuscr. 1999, Bittmann 2001
47			47	4H	x	?				G,L	Herbig 2002
40			40	5H+sev.G	x	x thin					Maier 2004
17	1P(div)		28	7H+sev.G	x					L	Maier 2004
6	*3P(18)*		*3*	*?*	*x*					*L*	*Maier 2004*
73		**73**	**x n.u.**	**8H+sev. G**	**x**	**xn.u.**			**xz.T.**		**Hosch 2003; Hosch & Jacomet 2004**
12	12P(33)			5H+6G	x	x n.b.		x n.b.	x z.T.		Brombacher & Hadorn 2004
16		16		?	x?	x? Pfahlverzüge				G?	Rösch 1990a
11		11		?	x?	x? Pfahlverzüge					Rösch 1990a
1	*1P(16)*			*?*	*x*	*x*				*G*	*Riehl 1993 ; Riehl not published*
1	*1P(5)*			*?*	*x?*						*Rösch 1990b*
3	*1P(1)*			*?*	*1*						*Jacomet 1990*
1	*1P(6)*			*?*	*1*	*1*				*G*	*Jacomet 1990*
3	*3P(8)*			*?*	*x*				*x*		*Karg 1990*
1	*1P(7)*			*?*	*5*		*2 sandy*				*Jacomet 1990*
4	*3P(9)*		*1*	*?*	*x*	*x*		*x*		*G*	*Karg 1990*
21		**21**		**ca 4H+sev.G**	**x**						**Favre 2001; 2002**
>22		**20**	**21 HSB**	**ca 6H+sev.G**	**x**			**x**			**Favre 2001; 2002**
39	11P(20)		28	?	12	24	12			G,L	Brombacher & Jacomet 1997
27	13P(22)		14	?	29	5	1	1		G	Brombacher & Jacomet 1997
67		57		min. 2H+?	x					L	Zibulski manuscr.
75	5P(68)		71	ca 4H+sev.G	61	21	43	14		G,E	Jacomet et al. 1989
46	>8P(15)		38	?	11	33	7	1		G,L	Brombacher & Jacomet 1997
5	*1P(6)*	*?*	*4*	*2H?*	*5+/-*			*1*	*4*		*Jacomet et al. 1989; Brombacher & Jacomet 1997*
9	*7P(7)*		*2*	*?*					*x*	*L*	*Brombacher & Jacomet 1997*
1?			*13*	*?*		*x*				*G*	*Jacomet 2004*
1			*1*						*x*		*Jacomet & Wagner 1987*
24	15P(18)		9	all G (?)	x	?			x		Brombacher 1997; 2000; Hafner & Suter 2000
69		41	28	?	x	x				L?,S?	Brombacher 1997
2			*2*	*1H?*		*x eroded*				*G?*	*Brombacher 1997*
5			*5*	*1H?*		*x*			*x*	*G*	*Brombacher 1997*
1	*1P(1)*		*7*	*?*	*x?*	*x*				*G*	*Piening 1981; Furger 1980*
49	**49P(49)**			**4H+sev.G**	**x**			**x**			**Baudais et al. 1997**
10			10 cf	1H+sev.G	x					G,S?	Schaal 2000
4			*4*	*?*					*x*		*Lundstrom-Baudais 1989*
3	*3P(12)*	*(14: not analised)*		*?*	*x*						*Lundström-Baudais 1986*
many?		*x?*			*x?*						*Bocquet, Caillat & Lundstrom-Baudais 1981*
22	10P(15)		12	?	10	4	10	3		L	Brombacher & Jacomet 1997
38	2P(15)	30	6	ca 4H+sev.G	25	8	12	5		G	Jacomet et al. 1989
>24		50 from 24 places (no coarse siev.)		5H+sev.G	x	?	x	x			Mermod 2000
37	6P(73)	z.T.?	31	ca 3H+sev.G	54	14	21	15		G	Jacomet et al. 1989
16	6P(16)		10	?	19		8			G.L	Brombacher & Jacomet 1997
13	5P(12)		8	?	12	6	2			G	Brombacher & Jacomet 1997
6	*6P(13)*			*?*					*13*		*Rösch 1990c*
4ca	*3P(29)*	*1*		*?*	*x*		*x*				*Jacomet 1980; Brombacher & Jacomet 1997*
5	*5P(7)*			*?*	*6*		*1*				*Brombacher & Jacomet 1997*
12	*6P(14)*		*6*	*?*	*15*		*2*				*Brombacher & Jacomet 1997*
1	*1P(3)*				*x*			*x*	*?*		*Schlichtherle 1985; Wolf 1993*
1	*1P(18)*				*x*			*x?*	*x?*		*Schlichtherle 1985; Wolf 1993*
19?		*19?*		*?*	*k.A.*						*Karg & Märkle 2002*
1	*1P(21)*			*?*	*from layer 8 bad preservation*						*Schlichtherle 1985; Wolf 1993*

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Table 1 List of Neolithic lakeshore settlements of the northern Alpine foreland with archaeobotanical investigations. Several methodological basics are indicated. Further comments see text. In bold letters: Representatively investigated settlements (category 1), in italics insufficiently investigated settlements (category 5). Abbreviations: preservation: F = waterlogged, T = dry mineral site. Dating: dendrodates. Regions (see Hafner & Suter 1997): BO = Lake Constance-Eastern Switzerland; BA = Bavaria; FO = Federsee-Upper Swabia; MZ = Central Switzerland; MW = Swiss Plateau-West; JU = French Jura. stocks: G = cereals; E = pea; L = flax; S = poppy; HSB = hearth area.

therefore we compiled also the number of contexts analysed (which corresponds to the number of «places» from which a sample was taken). In addition, we indicated the number of structures such as houses analysed, where this was possible; table 1 shows that this is known only in relatively few cases.

Systematically collected samples (type o in table 1) can be taken in two ways in Neolithic lakeshore settlement layers: as profile columns (Fig. 3) or as surface samples. In the latter case, material from e.g. 1 m^2 of the settlement layer is placed in bags or rigid containers. There is one important difference between these two methods: the volume of the samples coming from profile columns is much smaller, and this has an effect on the representation of some economically important taxa (see below 4.4.). Therefore, we also compiled the total volume of the samples in table 1.

Furthermore, the type of sediment investigated has a major effect on the taxa represented (Jacomet et al. 1989, 40–41 and 54–85). In lakeshore and mire settlements there are, on the one hand, layers consisting mainly of subfossil, uncarbonised organic materials and, on the other hand, burnt layers with mainly carbonised items, as well as places were inorganic materials like clay or stones (resulting from wall constructions or hearths) predominate. There are also mixtures between these sediments and strongly eroded layers. Therefore, information about the sediments is also listed in table 1.

Based on all these parameters, we classified the settlements as follows (number = code for 'representativeness'):

1 very good systematic sampling, with samples taken from much more than 20 locations in a settlement layer, several houses sampled, usually also judgment samples taken, several sediment types represented, archaeological evaluation made, different building phases distinguished.

2 good systematic sampling, with samples taken from at least 10 locations in a settlement layer, in most of the cases also judgment samples taken, but there is at least one methodological problem (mostly, the archaeological evaluation is lacking, making it impossible to distinguish settlement phases or the ground plans of houses, only small sample volumes etc.)

3 very few systematically collected samples from 3–9 locations in the excavation surface, but in addition a large number of judgment samples (>15) available.

4 only judgment samples taken, but many (far more than 20).

5 samples taken from fewer than 6 locations in the settlement layer and/or eroded layers only represented.

Of course these categories are partly subjective, but our experience of the last 25 years shows that there are indeed differences in the results depending on sampling. Objectively, it is clear that only settlements in category 1 are really representatively investigated, and that results of category 5 settlements may be very unrepresentative. Category 2 is almost equivalent to category 1, but the main difference is the lack of archaeological data (or rather, the archaeological data had not been evaluated when the archaeobotany was done). The results of category 3 and 4 settlements are mainly based on judgment samples: when evaluating such datasets one has to take into account that only single events are represented although such samples (even only one!) allow the precise reconstruction of single activities.

We did not record the way in which samples were processed, because precise information is almost never available. As recent investigations of the site Arbon Bleiche 3 show, however, the sieving method has a strong influence on the representation of some plant remains. Very fragile items like the remains of uncarbonised cereal chaff are totally eliminated when sieving is rough (Hosch & Zibulski 2003). This fact plays a decisive role when comparing the amounts (e.g. density values) from different settlements. In fact, for some of the economically important plants, such comparisons are simply not possible and published comparisons (including the author's own works!) have to be reconsidered.

In table 1 the settlements are grouped in chronological order. Within the main chronological groups mentioned above, we made regional "cultural" groups (regions after Hafner & Suter 1997, 549). As the main regions, we considered the Bavarian Alpine foreland, the Federsee/Upper Swabia Region (including the region of Ulm), Lake of Constance and Eastern Switzerland, Central Switzerland including Lake Zurich, Western Switzerland with the Lakes of Bienne and Neuchâtel, the French Jura and the Western Alps.

Fig. 3 Taking profile columns with the help of plastic tubes. On the right side the tubes are still sticking in the settlement layer, on the left side they were already removed (holes). Excavation Torwiesen, Bad Buchau (Germany, Baden-Württemberg), Sept. 2004, Foto S. Jacomet.

4. Results and discussion

4.1 Genesis of the cultural layers

The sedimentation modes of cultural layers were only very rarely systematically investigated. For this it is necessary, on the one hand, to take into account the fine-stratigraphy of the sediments (even sand-layers of 1 mm thickness count!) and, on the other hand, to analyse material along a lake-land transect in an excavation. The latter is necessary because the association of animal and plant remains along a lakeshore varies considerably. Such detailed work is only possible with the help of profile columns that are carefully separated into single samples in the lab. In addition, a multidisciplinary approach is needed, which was carried out only in Arbon Bleiche 3.

From investigations during the 1970s and 1980s in the Zurich region, we know that before the onset of building activities the lake level must have been considerably lower (Jacomet 1985; Brombacher 1986; Dick 1989). The cultural layers there were deposited under wet conditions, but they are not directly influenced by water (aquatic plants are more or less lacking). In the settlements, nitrophilous plants of wet, ruderal habitats grew. Also the multidisciplinary investigations of Arbon Bleiche 3 on Lake Constance give indications of similar scenarios (Haas & Magny 2004; Brombacher & Hadorn 2004; Ismail-Meyer & Rentzel 2004; Thew 2004; Deschler-Erb & Marti-Grädel 2004a). The settlement was built on an almost vegetation-free beach after a considerable lowering of the lake level. The cultural layer consisted of a very small-scale patchwork of different materials (rubbish, insulation materials, excrements etc.). It is almost certain, therefore, that these materials are preserved *in situ*. At least at some locations, materials from different years must be represented, so the sedimentation was more or less continuous. At the end of the settlement phase, the water level rose considerably and one can detect the appearance of aquatic plants typical of eutrophic environments.

All in all, one can conclude that the samples from most of the lakeshore settlements mirror very well the ancient activities at the site of their deposition. This is corroborated by house-wall structures preserved *in situ* at the site of

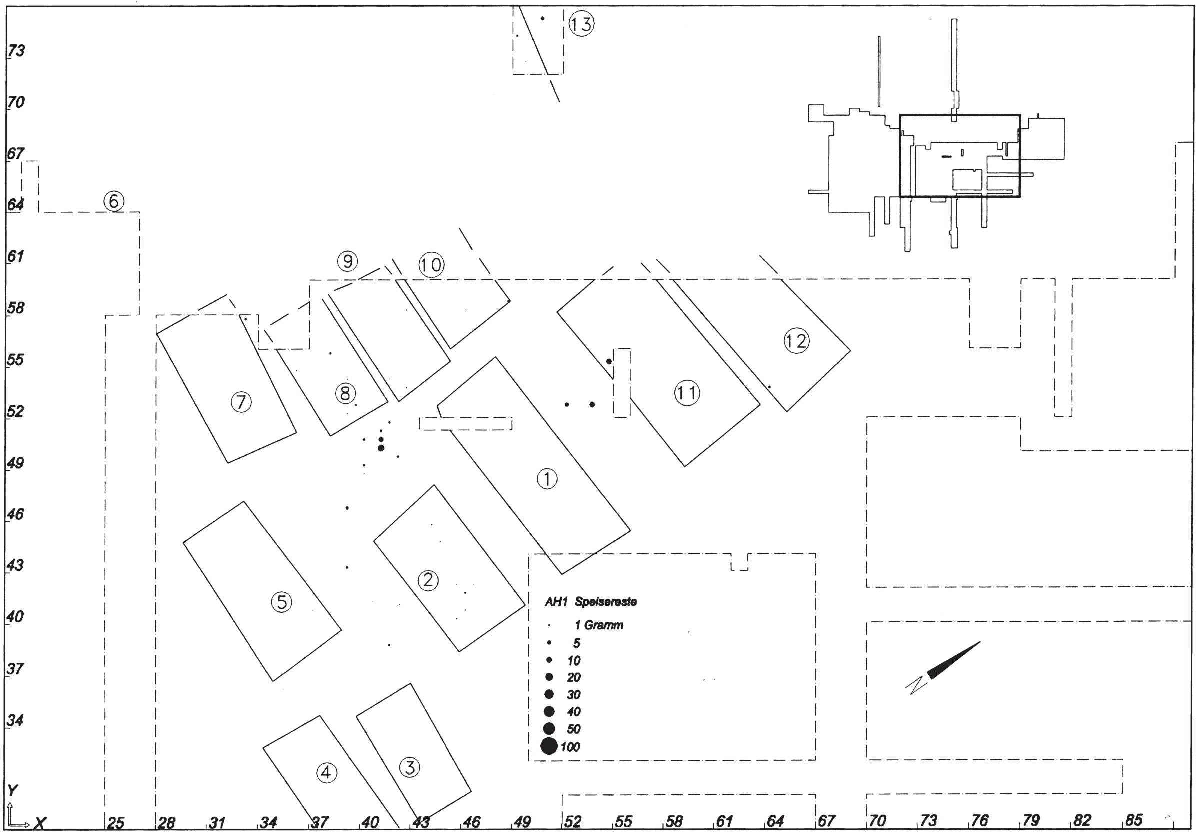

Fig. 4 Plan with houses of Hornstaad (from Maier 2001, Abb. 48).

Zürich AKAD/Pressehaus, layer J, and in the case of Arbon Bleiche 3 by the distribution of the larger animal bones and artefacts. For further statements about Hornstaad Hörnle IA see Maier (2001, 142–152; deposition season of coprolites). Flooding did not affect the whole of the settlement area and had also almost no erosive influence.

It is not possible to judge if the scenarios mentioned above are appropriate for all lakeshore settlements. There is at least one example from our research where aquatic plants were very widespread in the settlement layers (Cham ZG Eslen, Martinoli & Jacomet, unpublished data).

4.2. Sampling strategies

In the following we describe some examples of good / adequate sampling strategies and discuss their advantages and disadvantages.

Hornstaad-Hörnle IA on Lake Constance (Baden-Württemberg, Germany) can be regarded as the best investigated site – as regards archaeobotany – in the whole lake dwelling area in the surroundings of the Alps. The settlement is dated to the 40th century BC (Hornstaader Group, beginning of the Pfyn culture). Here, several thousand samples were analysed (Maier 2001). In contrast to most of the other examples discussed here, this site was excavated during a research programme under the direction of H. Schlichtherle. Another advantage was that the settlement existed for only a very few years (3917–3905 BC based on dendrochronological dates) and the settlement layer had a simple structure: after a very short settlement phase, represented by a thin organic layer (AH1), the village burnt down, shortly after the harvest of the cereals; this produced the burnt layer AH2. After this, the houses were rebuilt and for some further years an organic layer was deposited above the burnt layer (AH3). 11 houses were uncovered in the carefully excavated part of the area (Fig. 4). The excavation (1979–1983) was followed by a multidisciplinary evaluation project. Based on architectural remains and the structure of the cultural layer the archaeologists assume that the houses were built on piles (Dieckmann 1990; Dieckmann et al. 2001).

The sampling was made in such a way that many inferences concerning intra-site patterns should be possible:

a) *systematic surface sampling:* The basis for the documentation of the AH1 and AH2 layers was a so-called «Röhrchenprogramm» (tube program) (Fig. 5). Two plastic tubes of 7cm diameter were pushed into the ground of every square meter before removal of the layers (similar to Fig. 3). In total, 1313 tubes were

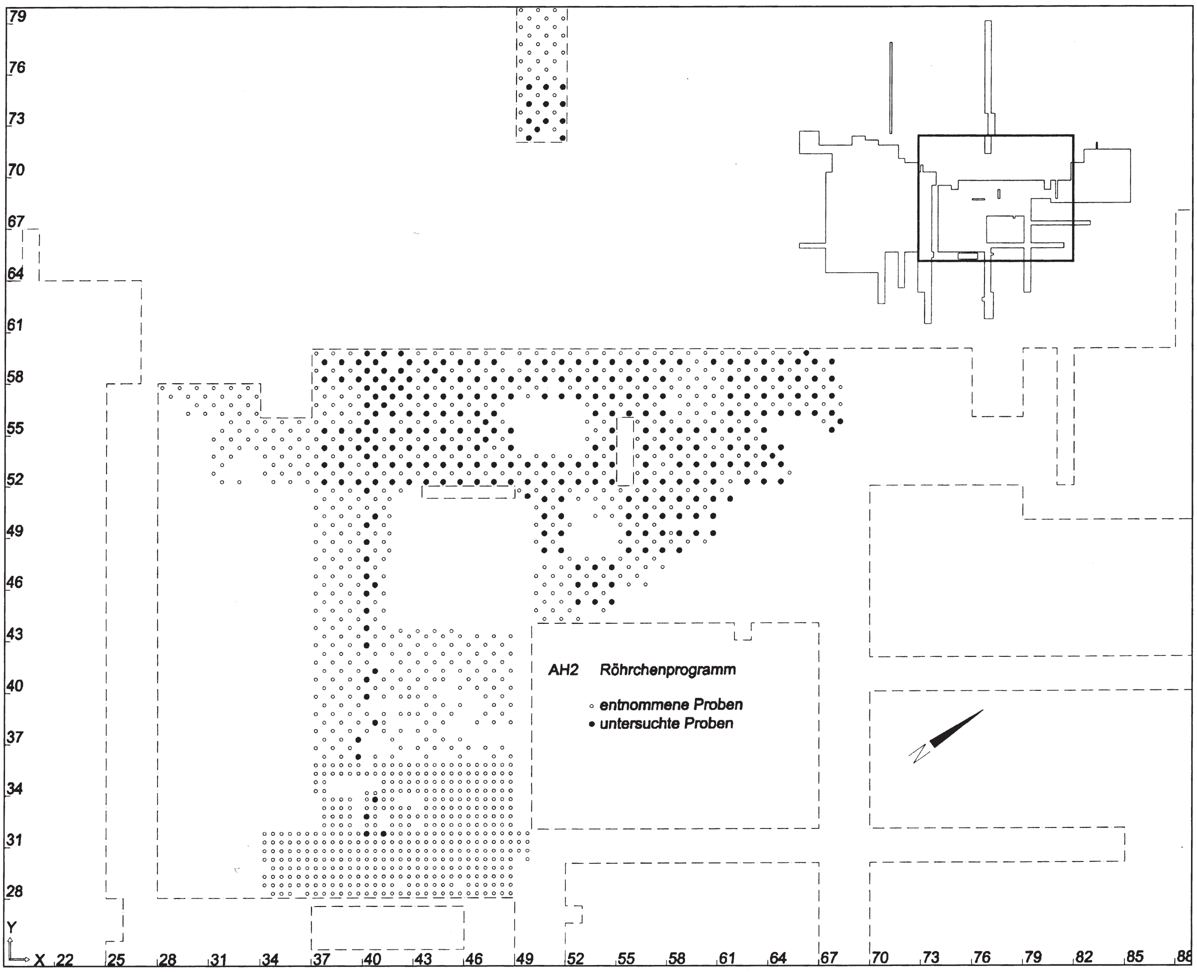

Fig 5 Systematic sampling of the settlement layer of Hornstaad Hörnle IA with the help of plastic tubes (from Maier 2001, Abb. 11).

taken. 299 were analysed (Fig. 5), covering the most well preserved parts of the layer. The volume of the samples was 270 ml on average. In addition to the tube program, the organic (rubbish) layers AH1 and AH3 were also sampled systematically (the so-called «Detritusprogramm»). From every second square meter, one to several samples were taken – from every fine layer separately. The volumes of these samples averaged around 300 ml. However, only a relative small part of the excavation area was sampled (Maier 2001, 20). Of the total of 170 samples, 79 were analysed (34 from AH1 and 45 from AH2). This is a rather high number.

In addition, almost the whole excavated soil of the cultural layer per square meter was coarse-sieved through a 3mm mesh (so-called «Siebfunde»). In addition to small archaeological artefacts, large amounts of large-seeded botanical remains were found, such as sloe, hazelnuts etc.

b) *judgment sampling*: In addition to the samples already mentioned, the excavators collected all visible plant remains (another >4000 samples; Maier 2001, 20–21). Examples are cereal ears, prepared food remains, coprolites/excrement, flax-stalks, mosses etc.

c) *profile columns*: at 11 locations, spread across the whole excavation area, profile columns were taken, of which 8 were analysed. The goal was to reconstruct the genesis of the layers. However, a planned interdisciplinary evaluation didn't take place (pers. comm. U. Maier).

The sampling in Hornstaad covered the most well preserved parts of the settlement layer continuously and made it possible to choose appropriate samples after the excavation and to define sensible priorities.

A surface sampling strategy was also applied in Arbon TG Bleiche 3 on Lake Constance (Canton Thurgau, Switzerland). This settlement was excavated during a rescue excavation in the summers of 1993–1995 under the direction of U. Leuzinger (Leuzinger 2000). Already on the excavation, ground plans of over 20 houses were visible and it became clear that the settlement period must have been short. This was corroborated by dendrochronological analyses (Leuzinger 2000; Sormaz 2004). The building year of each house could be dated (Leuzinger 2000, Abb. 244–251). The excavated part of the village existed between 3384 and 3370 BC and belonged to a transitional phase between the Pfyn and Horgen cultures that was hardly known previously (de Capitani et al. 2002). Because of the excellent preservation of the (mainly organic) settlement layer and the simple stratigraphy, we decided to carry out an extensive surface sampling. In the years 1994 and 1995, when the best preserved parts of the layer were excavated, samples were taken in two parts of the surface from every second quarter of a square-meter. The remaining part of the 1994 excavation area was sampled every second square meter. Unfortunately, during the final phases of the excavation in 1995, because of shortage of time, it was not possible to continue this systematic sampling; therefore, parts of 4 houses are not very well covered by samples (Jacomet & Leuzinger 2004, fig. 12). In any case, with over 500 samples of mostly over 10 litres, the cultural layer is covered very well. We chose such large sample volumes because it was not possible to sieve the whole layer in Arbon Bleiche 3, but we wanted to recover also large-seeded plants, wood remains including twigs and the remains of small animals (Hosch & Jacomet 2001; 2004). Judgment samples were also taken in Arbon Bleiche 3, but these were mainly coprolites.

In several parts of the excavation, profile columns were also taken. In 1995 plastic tubes of a diameter of around 10 cm were placed according to a grid system (distance of 3–4 meters). They were inserted into the ground before excavating the settlement layer. In addition, several columns of 60 x 20 cm were taken (Jacomet & Leuzinger 2004). After the excavation the structures were evaluated (Leuzinger 2000). At this point, the multidisciplinary evaluation project was initiated, financed by the Canton of Thurgau and the Swiss National Foundation. The results are presented in the publications of de Capitani et al. 2002 and Jacomet, Leuzinger & Schibler 2004a.

For a closer investigation, we chose 8 houses from the best preserved part of the layer. Because there was not enough time to analyse all the samples, we needed first to define how many samples would provide an accurate picture of the useful plants from one house unit (Hosch & Jacomet 2001). Therefore, 8 samples from every house and in addition 9 samples from areas in between the houses were analysed. In total, 73 samples with a volume of 340 litres were investigated, which is by far the largest volume investigated so precisely from a lakeshore settlement (Hosch & Jacomet 2004). Of the judgment samples, only the coprolites were investigated (Le Bailly & Bouchet 2004; Akeret & Rentzel 2001).

In addition to the surface samples, 12 of the profile columns were analysed (plus 3 for micromorphology only). They lie along the lake shoreline (Jacomet & Leuzinger 2004, fig 14). The goal was primarily to reconstruct the genesis of the layers. In addition, the selected dataset allowed a comparison between spectra in the profile columns and the surface samples (see 4.4.).

A good surface sampling strategy was also carried out at the site of Horgen-Scheller at Lake Zürich, which was excavated in 1987–1990 as a rescue excavation under the direction of U. Eberli from the Kantonsarchäologie

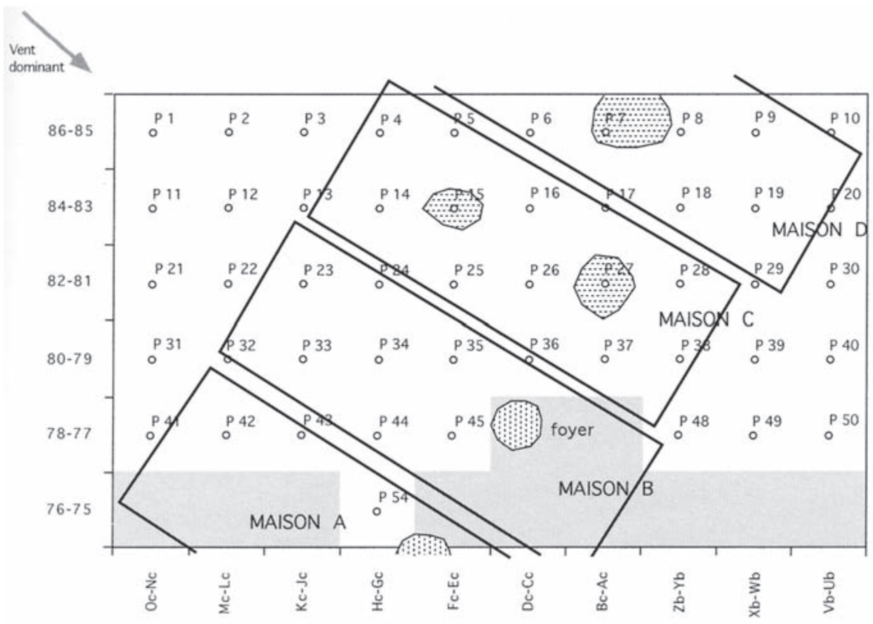

Fig. 6a Systematic sampling of the settlement layer with plastic tubes (Pétrequin 1997c, 43).

Zürich. The settlements of layers 3 and 4 belong to the Horgen culture (31st century BC), and were settled only during short time periods of max. 15 years (Eberli et al. 2002a, 102–118). In the lower layer 4, ca. 3 houses were documented, in layer 3 four. The cultural layers were composed of organic material and hearth structures. A systematic surface sampling was done: in the best preserved part, a sample of about 1 litre was taken from every second square meter, comprising the whole organic layer, with the help of plastic boxes (Favre 2002, 150, Abb. 177). Some of the hearth areas were sampled in a special way (more samples, every thin layer separately). In total, 190 samples were taken, of which 65 were analysed. In addition, the twigs were collected systematically by square meter (Favre & Jacomet 1998).

A sampling programme rather similar to the tube programme of Hornstaad was carried out at the research excavation in Chalain Station 3, niveau VIII in the French Jura (Pétrequin 1997a). There, a settlement of the Horgen culture, dendrochronologically dated to 3198–3149 BC, was excavated (Lambert & Lavier 1997, 57; Pétrequin 1997b, 29). However, there only a small surface of 12 x 20 m (300 m^2, of which 129 m^2 «zone de dépôtoirs») with 4 houses was investigated of which 2 were more or less fully uncovered (Pétrequin 1997c, 43; Baudais et al. 1997, 723, Fig. 6). There was a very well preserved organic layer of 10 cm thickness (Pétrequin 1997c, 39–46). The sampling was carried out with the help of 60 plastic tubes having a diameter of 12 centimeters (one from every second square meter; Fig. 6a). Of the 60 samples, 49 were analysed. The average volume of the samples was small, only 270 ml. A similar sampling was carried out in Sipplingen (D) Osthafen during underwater excavations in 1998 and 1999 (Riehl 2004, 11–13).

In the cases of Horgen ZH Scheller and Chalain (F) station 3, the systematic sampling of the surface was rather good. However, in both cases larger-seeded specimens are perhaps not well represented. A disadvantage is also that no subjective samples were taken at either site.

In the case of all the excavations mentioned above, the archaeological evaluation was done parallel with, or shortly after, the archaeobotanical investigation. Therefore, it was possible to consider archaeological data during the evaluation of the archaeobotanical data. There are some more rather well or even very well sampled excavations where this was not the case. For further details see the publication of Jacomet [c].

Worth mentioning are finally some settlements from the Federsee region (Schlichtherle 2004). There, as at Hornstaad, in addition to a systematic tube-sampling also large amounts of judgment samples were taken. The investigations, published in 2004, concentrated on those samples, which should give good information about intra-site patterns (Maier 2004, 77). A good example is the settlement Alleshausen-Hartöschle of the Schussenried culture (3920–3916 BC). There, from the 3 excavated houses, 2 and the area between them were investigated (for the plan see Maier 2004, 78). This strategy made it possible, for example, to reconstruct the function of the oven construction in one of the houses.

The examples mentioned above show that not only on research excavations but also on rescue excavations a good sampling programme is possible.

4.3. Results relating to 'intra-site-patterns'

4.3.1 Results based on systematic surface sampling

With the help of the tube programme, Maier (2001, 64) could show that the distribution of food remains is different in the organic AH1 and AH3 layers of Hornstaad Hörnle IA, on the one hand, and in the burnt layer AH2, on the other: in AH1 and AH 3 they were found outside the houses and represent rubbish which was thrown out. In the burnt layer, such food remains are mainly inside the houses (Maier 2001, 65). They represent food in preparation or already cooked when the fire destroyed the village.

The surface samples of the organic layers («Detritusprogramm») yielded a lot of other information concerning rubbish: remains of flax were concentrated only in a few places in the AH3, e.g. in the organic layer 206 where the rubbish zones of two houses overlap (Maier 2001, 70, Abb. 54). Flax remains were therefore not deposited everywhere in the settlement, but rather were concentrated in certain places where other rubbish was also deposited. Similar observations were made on layer J (around 3710 BC, Pfyn culture) at the site of Zürich AKAD/Pressehaus by Jacomet (1981, 137). In contrast, at the much younger site of Arbon TG Bleiche 3, flax remains were much more common and were found everywhere. However, the densities are slightly higher in the areas between the houses (the same pattern is visible in the case of cereal chaff). This points to the fact that, here also, rubbish was thrown outside of the houses.

At Hornstaad Hörnle IA in some of the areas between the houses there were large amounts of pea pods (e.g. in the organic layer 206, between houses 11, 1 and 10; Maier 2001, 73 ff., Abb. 57). These represent cleaning residues the inhabitants disposed of outside the buildings. In the mire site Seekirch-Stockwiesen (Goldberg III-Group, shortly after 3000 BC) in the Federsee region rubbish heaps including dung and human coprolite-zones were found beside the houses (Maier 2004, 91–95).

In Chalain station 3 (F) good results were obtained concerning the processing of cereals. Large amounts of uncarbonised chaff were found at the narrow end of one of the two nearly complete houses (Fig. 6b). Therefore, it seems very probable that winnowing took place on a sort of open balcony outside where the wind was blowing. The

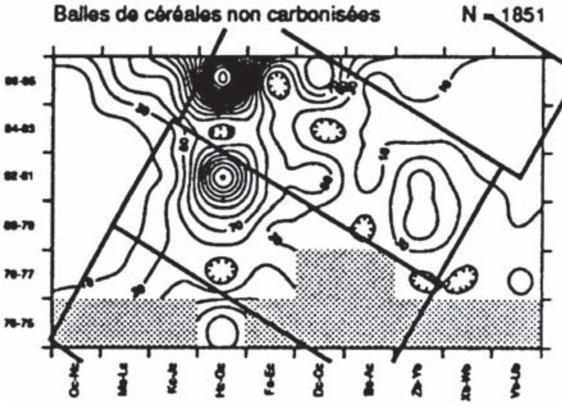

Fig. 6b Distribution of uncarbonised cereal chaff. Excavation Chalain (F) station 3 (Baudais et al. 1997, 730, Fig. 5).

wind may also be responsible for the deposition of cereal remains under the houses, which in Chalain station 3 are reconstructed as pile dwellings. Similar scenarios can be envisaged for Arbon Bleiche 3: also there, the density of uncarbonised chaff in areas between the houses was much higher than inside (or under) the houses.

The distribution of remains inside houses is strongly dependent on the way they are built. If the houses are built directly on the ground, the differences between surfaces inside and outside a house should be rather clear as, for example, in the case of Horgen ZH Scheller (Eberli et al. 2002b, 207–208) or the houses in the Federsee region (Schlichtherle 2004). If the houses are constructed as pile dwellings, as reconstructed for the settlements on Lake Constance, and also at Chalain station 3, the differences should not be so great.

When layers representing very short events are found, it is possible to reconstruct in detail the differences or similarities between houses. The investigations of the burnt layer AH2 at Hornstaad Hörnle IA, in particular, provided a lot of information concerning the storage of cereals and agricultural activities (Maier 2001, 32–50). Obviously, the settlement burnt down shortly after the harvest and large amounts of unprocessed cereals were stored (as whole ears) in the houses. It could be shown that every house had its own stores and that there were no special storage buildings. There were, however, some differences between the buildings. For instance, in house 1 there was a higher diversity of stored crops (naked and glume wheats), and dill was regularly present. It was also in this house that copper objects came to the light (Maier 2001, 38, 44, 49–50). So, this house perhaps had a special position. The morphological comparison of the ears allowed even the reconstruction of different landraces (Maier 2001, 180–190). Evaluation of the weed seeds in the crop stores allowed a detailed reconstruction of agricultural activities (Maier 2001, 78–109). In contrast to cereals, larger stores of flax were found only in house 11.

The evaluation of the plant remains in the burnt layer AH2 also demonstrated that several wild plants were used. In the southwestern part of the settlement, seeds of some Brassicaceae (oil-rich and therefore nutritious seeds) like *Brassica campestris* and *Descurainia sophia* show very high densities (see already Schlichtherle 1981). They must represent remains of stores. There is also other information concerning the use of wild plants (see Maier 2001). Such information is of course mainly available when the remains are embedded *in situ* in burnt layers.

In Horgen-Scheller, where the houses are thought to be built directly on the ground, significantly more carbonised remains are present in the hearth structures (Favre 2002, 175–176). This demonstrates their use in cooking. Similar results were obtained for Chalain Station 3 (Baudais et al. 1997, 730, Fig. 5) and also Concise Sous Colachoz (Lake Neuchatel), Ens. 2 (Cortaillod Moyen; Märkle 2000, 75). The density of plant remains in general was also much lower in the zones of the hearth structures; this can be due to the fact the these zones were cleaned regularly, the rubbish being deposited in areas between the houses (Schicht 4; Favre 2002, 161–162). In the mire site Alleshausen-Hartöschle, Maier (2004, 78-79) found large amounts of carbonised cereals in the zone of the oven. This suggests that the oven was used for the handling and cooking of cereals.

Concentrations of silver fir twigs were found at Horgen ZH Scheller in cultural layers inside the houses; they were used as filling or insulation material (Favre 2002, 160; Eberli et al. 2002b, 208). In Chalain station 3 (Baudais et al. 1997, 703) a concentration of poppy seeds was found inside one of the houses. In contrast, at Arbon Bleiche 3 poppy seeds were found everywhere in large amounts (Hosch & Jacomet 2004).

How could plant remains occur under houses thought to have been constructed as pile dwellings? One possibility would be disposal through a sort of trap-door in the floor. At Chalain station 3 (Baudais et al. 1997, 725 ff.) there are some indications of such an opening: a zone with a high density of plant remains in the back part of one house (C) is interpreted as rubbish heap or toilet. One can infer the existence of a *trappe de vidange*. Here, hazelnut shells, carbonised cereal chaff etc. are mixed. Also the distribution of bones and other artefacts points to the existence of a rubbish heap. Another possibility is that light plant parts can be transported under the houses by wind (see above).

In several settlements – Horgen Scheller (Favre 2002), Concise Sous Colachoz (Märkle 2000, 77 ff.) and Chalain Station 3 (Baudais et al. 1997) – it could be shown that e.g. hazelnut shells show a different distribution on the surface than some berry seeds or apple remains. The latter were probably deposited as excrement and reflect «toilet-zones» (see also Maier 2001, 142–152 in Hornstaad Hörnle IA), whereas hazelnut shells are indicators for rubbish. Similar observations on distribution were made for Arbon TG Bleiche 3 (Hosch & Jacomet 2004).

In Arbon Bleiche 3 it could be shown that in the zone of house 14 the density of hazelnut shells was very much higher than in the other parts of the settlement (max. 934 pieces/litre, average: 172 pieces/litre; Hosch & Jacomet 2004). It is therefore very probable that the inhabitants of house 14 gathered many more hazelnuts than the other inhabitants. The shells were discarded under the house. There are several other examples for such patterns in Arbon Bleiche 3.

4.3.2 Results obtained by the analysis of judgment samples

From many settlements there are analyses of stores of cultivated plants (Table 1). They can give very detailed information about agricultural activities and storage of cultivated plants. Especially the weeds in these stores are very important because they give detailed information about sowing time, fallowing, crop rotation etc. However, the results of the evaluations of those weed spectra are somehow contradictory and one should evaluate them with the help of newly developed methods (for an overview of the state of research, see Hosch & Jacomet 2004; as an example of such a research see Bogaard 2004).

The systematic collection and mapping of coprolite samples in Hornstaad Hörnle IA showed that excrement is concentrated in specific zones outside the houses (Maier 2001, 152; Abb. 14). The composition of the berry-concentrations permits reconstruction of the season in which they were deposited (Maier 2001, 150-152, Abb. 90). Some zones obviously were used as toilets for a longer time period. Moss polsters exhibited a completely different distribution. They can be interpreted as raw materials for house building (Maier 2001, 162). Similar observations were made in Chalain Station 3 and Horgen ZH Scheller (see above).

The investigation of some human coprolites from Hornstaad Hörnle IA brought some very detailed insights into the nutrition of the inhabitants (Maier 2001, 143–152). Cereal bran was found almost everywhere and in large amounts (Maier 2001, 245). Therefore, cereals were the most important basic foods. Pea was also eaten as green pods (Maier 2001, 149). Even dill was found in the coprolites (Maier 2001, 148). Not only «usual» wild fruits (Maier 2001, 145), but also a large number of other wild

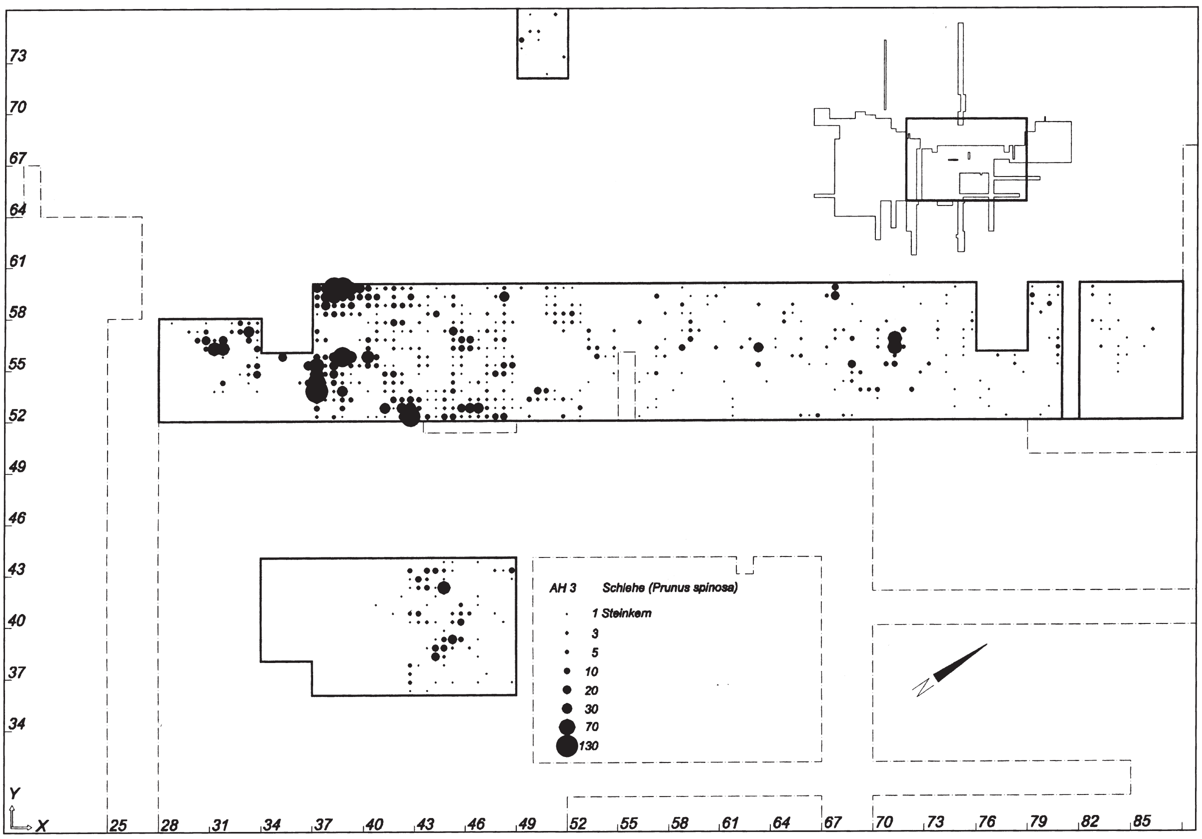

Fig. 7 Distribution of sloe stones in the organic layer AH3 of Hornstaad Hörnle IA (from Maier 2001, 118, Abb. 74).

plants, were eaten (Maier 2001, 148 ff.) including the «weeds» *Chenopodium album* (in 41% of the coprolites) and *Fallopia convolvulus* (in 25% of the coprolites). *Physalis alkekengi* was found at Arbon Bleiche 3 in a pot-crust, which shows that it was part of cooked dishes (Martínez Straumann 2004).

One of the coprolites investigated at Arbon Bleiche 3 appeared to be of human origin because its composition differed markedly from the ruminant coprolites and showed similarities with plant remains found in pot-crusts (Kühn & Hadorn 2004; Martínez Straumann 2004). It was composed of many bone fragments and remains of cultivated plants. There was a lot of cereal pollen and bran, remains of linseed and some apple-pericarps. It is not possible to say whether these items were eaten separately or as a combined dish.

The coprolites from Hornstaad Hörnle IA also provided several indications of medicinal treatments. Clearly, mistletoe was used as medicinal plant (Maier 2001, 149).

At Arbon Bleiche 3, investigations of intestinal parasites in human coprolites provided a lot of information about the hygiene situation and the health of the inhabitants (Le Bailly & Bouchet 2004). In all of the coprolites, several tape-worm parasites were found which cause life-threatening diseases like cestodiasis. Therefore, the health status of the inhabitants could not have been very good, and basic hygiene was obviously not known.

Also in Arbon Bleiche 3, analyses of ruminant dung provided plenty of information about animal fodder (Akeret & Rentzel 2001; Kühn & Hadorn 2004; Haas 2004). First of all, only dung from the winter season was found. The animals grazed for themselves in the surroundings of the settlement, but they were also foddered, with silver fir, ivy, mistletoe and also leaf hay, and with catkins. Analyses of the twigs (Zibulski 2004) showed that the leaf hay was not stored inside the settlement. Most probably, some sort of depôts must have been existed near to the settlements. For more information with the help of judgment samples see also Maier (2004) or Herbig (2002).

4.3.3 Results obtained by coarse-sieving

The investigation in Hornstaad (D) Hörnle IA showed that, in small samples (<300 ml) (from the tube and detritus sampling programmes), species with larger fruits are underrepresented. This was shown by the coarse-sieving programme (Maier 2001, 116, 119, 127 and 141). Already Jacomet (1981, 133) and Jacomet et al. (1989, 72) suggested this, but could not prove it conclusively (for further evidence see also Mermod 2000). For example, sloe stones were only sporadically present in the small samples, whereas there were over 4000 in the coarse-sieve samples. In addition, all the 59 stones of cornelian cherry come from the coarse sieve samples and also the majority of the ca. 1000 kernels of *Cornus sanguinea*.

The distribution of these finds in the settlement layer shows that e.g. the sloe stones are exclusively concentrated in the zones of two houses (8 and 9; Fig. 7). There, obviously special activities in connection with sloe were carried out. Perhaps sloe was gathered only by certain people. The kernels of *Cornus sanguinea* show a totally different distribution than sloe stones (Maier 2001, 142–144): they appear to be concentrated in the northern part of the settlement. These distributions prove an intentional use of sloe and *Cornus sanguinea* and they point to a specialisation of the inhabitants of some houses relating to special gathering activities. The same could be shown in Arbon Bleiche 3 (see below).

4.3.4. Results with the help of different samples: differences between house units

In terms of cultivated plants, the single house units seem to be «economical» units. Mostly, the spectra of the cultivated plants in the houses are rather uniform (Maier 2001; Hosch & Jacomet 2004). There are only 2 exceptions visible in Hornstaad Hörnle IA (see above mentioned facts; Maier 2001, 38, 44, 49–50 and 68). Even if the spectra of the other houses in Hornstaad and of Arbon Bleiche are uniform, this does not mean that the inhabitants of several houses did some agricultural work together (preparing of the soil for sowing, harvesting). On the other hand, if one looks at the reconstruction of the year-round activities for Arbon Bleiche 3 (Jacomet, Leuzinger & Schibler 2004b), one can conclude that this was indeed necessary: without organisation amongst households it was not possible to carry out all the work necessary for survival.

Larger differences between houses or even «quarters» of villages are visible when looking at gathered plants (and also hunted animals) (see examples already mentioned from Hornstaad Hörnle IA). Similar patterns are visible in Arbon Bleiche 3 (Hosch & Jacomet 2004). As already mentioned, in 3 houses there are much higher concentrations of gathered plants. As at Hornstaad Hörnle IA (Maier 2001, 162), there was one location (house 20) with large amounts of *Arctium*. At the same time, in the zone of house 20 the proportion of hunted animals, mainly fur-bearing animals, is very high (Deschler-Erb & Marti-Grädel 2004b). It was also observed that the inhabitants of the houses which lie nearer to the lake shore had a different fishery technique (requiring boats) than the inhabitants of the other houses (Hüster Plogmann 2004).

To conclude, in the few sites where we can say something about this topic, there seem to be larger differences between houses concerning gathering (and hunting) than concerning cultivation. The inhabitants of several houses seem to have been more focused on gathering activities than others. We think that we cannot simply regard the house as an «independent economic unit»; a more differentiated view is necessary.

4.3.5 Conclusion

Many of the relevant results concerning intra-site patterns (which were elaborated with the help of plant remains) came from research excavations carried out in southern Germany (mainly Hornstaad Hörnle IA and the Federsee settlements). Results from Switzerland are much more rare although the number of excavations carried out is much higher. These were rescue excavations where only very rarely – as in the cases of Horgen Scheller and Arbon Bleiche 3 – a systematic research strategy was developed. This is due to infrastructural deficiencies in the organisation of archaeological research in Switzerland.

The results highlighted show that the reconstruction of intra-site patterns is only possible when the excavated surfaces are, on the one hand, large enough and, on the other, when this surface is systematically sampled. The distribution of different remains shows clearly that gaps in the sampling can result in serious misinterpretations. What also becomes clear is the fact that only very small excavated surfaces can produce a picture which can be totally different from the «average». Spectra of small excavation surfaces (as parts of larger villages) have to be interpreted with caution and are perhaps not representative for the whole village. However, they can contribute to a detailed knowledge of the excavated part.

It has also become clear that it is important to observe very carefully the layers during excavation and to carry out judgement sampling. Such judgment samples allow – even as single samples – very precise information about single activities.

It has become apparent also that locations that were occupied only for a very short time and therefore have a «simple» stratigraphy are best suited for gathering information about intra-site patterns, because surface sampling does not cause larger problems. Most of the information mentioned until now come therefore from such sites. In sites with several settlement phases, the sampling is more complex and the investigations much more expensive (see below, 5.).

4.4 The influence of sample volume, the number of counted remains and sampling density on the results

4.4.1 sample volume and number of counted remains

As already mentioned in 4.3.3, the results of coarse sieving programmes have shown that large-seeded plants are under-represented in samples with a volume of <1 litre. This was the reason why our first goal at Arbon Bleiche 3 was the determination of an «optimal» sample volume in which large-seeded taxa as well as the remains of wood, twigs, small animals etc. would be well represented. The basis for determining the right sample size consisted of the numbers given by Van der Veen & Fieller 1982. For waterlogged material from lakeshore sites, it is appropriate to look at every fraction separately (it is necessary to work with not more than two fractions, e.g. 2mm and 0,5mm, as at Arbon Bleiche 3). For recording the correct proportion of a taxon with a probability of 95 ± 5%, it is necessary to count at least 341 items. This number concerns only taxa with a minimal proportion of 10%, which are the economically important taxa (for the recording of rare taxa, see below). Seeds and vegetative remains have to be counted separately.

A comparison of two different sample volumes from the 1994 excavation at Arbon Bleiche 3 (1 litre and 10 litres) gave the result that 3 litres are enough for a statistically representative recording of larger seeds (≥ 2 mm; Hosch & Jacomet 2001, 66). On average, a subsample size of 460 ml of the large fraction was necessary for counting 341 items.

For the recording of smaller-seeded taxa like flax, berry seeds, poppy seeds as well as cereal chaff, much lower volumes are sufficient. In a sample of 500 ml of an organic layer there are usually more than enough remains. At Arbon, already a subsample of on average 8 ml of the 0,5mm fraction contained enough remains.

To conclude, for a statistically relevant recording of larger-seeded taxa at Arbon Bleiche 3, around 60 times more material was needed than for the recording of the smaller items. This must be assumed also for other Neolithic lakeshore settlements. However, this number depends on the preservation of the layers: at Arbon the preservation was excellent and therefore the find density was very high. This is not always the case, as could be shown by Jacomet et al. 1989 (62–81). On average, the optimal sample volume is perhaps higher, at about 5–10 litres or even 15 litres. The latter was the case, for example, at Pfäffikon ZH Burg (unpublished data of Petra Zibulski, IPNA, Basel University). It must be stressed that the given sample volumes concern only organic layers very rich in uncarbonised plant material.

Very important is also the definition of units that are counted (in order not to count e.g. 1 hazelnut or one flax seed several times; see for lakeshore settlements e.g. Hosch & Jacomet 2004). Until now, however, this was almost never practised properly. Counts of seeds from Neolithic lakeshore settlements, therefore, are difficult to compare directly. Only very large differences can be interpreted when one has also information about the method of sieving and many other parameters (like sample volume and the density of sampling).

At only a few excavated settlements, the sample volumes were high enough to have a good representation of the large-seeded taxa, mainly due to coarse sieving programmes during the excavation. These sites are Arbon Bleiche 3, Hornstaad Hörnle IA, Zürich AKAD/Presshaus Schicht J (Flächenproben Abstich 1), Pfäffikon ZH Burg and St. Blaise Bains des Dames. It is also possible to obtain a good idea about the importance of such taxa with the help of very thorough judgment sampling. This, however, is very dependent on the knowledge of the excavators. Also a very dense, systematic surface sampling with smaller samples can give an appropriate picture, but such a strategy was rarely pursued. Therefore, only from a very few places it is possible to judge the role of large-seeded taxa like hazelnuts, acorns etc. in nutrition. This is also the case, by the way, for other larger objects like twigs, wood, remains of dung or remains of smaller animals. Only at Arbon Bleiche 3 did we define in advance the targets and use a defined counting system (Hosch & Jacomet 2004).

Up till now it is also not known how many remains per sample one should count (and based on that how large the volume of the sample has to be) for recording the total diversity at a site. There are hardly any systematic investigations concerning that problem (see for example Vandorpe & Jacomet [b]). Jacomet et al. (1989, 71) showed that sample volumes below 1 litre (only organic layers concerned) most probably are not high enough for recording all taxa originally present. At Arbon Bleiche 3, on the basis of the 90 taxa found in 17 samples of one small part of the excavation, we made a rarefaction analysis; this showed that much more than 90 taxa could be expected (Hosch & Jacomet 2001). Even with all the 73 samples, not all possible taxa were recorded. The number of items counted per sample in Arbon was therefore not high enough to record also the rare taxa (see above). Indeed, the 32 rare taxa (only present in 1 sample) cause the results of the rarefaction analysis. Therefore, in most of the investigated sites mostly such taxa are represented which were brought into the site regularly, e.g. with the harvest or through gathering, dung of animals etc. This means that reconstructions of agricultural activities, the gathering economy or the fodder of the animals are possible, since taxa connected with those activities reached the site regularly.

Is it really necessary to be concerned about rare taxa? Yes, it is, because for example at Arbon Beiche 3 the rare taxa also gave very interesting insights into the economy. Plants that were probably introduced from greater distances (even from south of the Alps) were found only very rarely (Hosch & Jacomet 2004). Nevertheless, they are of great interest. Therefore, it is necessary to work out strategies for an appropriate recording of rare taxa (see also below 5.4.).

4.4.2. Influence of sampling density on the results

Many of the Neolithic lakeshore settlements were sampled with the help of profile columns or small surface samples of 500 ml to max. 1 litre from about 10 (but rarely more than 20) places in the excavation surface (see table 1). From almost 50% (39 of 86) of the settlements, only the investigation of one single profile column or under 5 surface samples was carried out. In the following, we want to discuss how the results based on such a small number of samples can be interpreted.

Usually, it is not possible to do this because only one type of sample was analysed. In the case of Arbon Bleiche 3, it is possible for the first time because we analysed several sample types in the frame of a larger research project (Jacomet, Leuzinger & Schibler 2004a). Therefore, it is now much more feasible to judge the representativness of many former analyses.

At Arbon Bleiche 3, with the help of large bulk samples (min. 3 litres each), 8 houses were investigated as well as areas in between (Jacomet & Leuzinger 2004, fig. 14). In total, 73 such samples were analysed with a total volume of 340 litres (Hosch & Jacomet 2004). The main goal of the investigation was to record the economic plant spectrum of the houses in order to make comparisons between them. In addition, we wanted to find special activity areas.

The main goal of the investigation of 12 profile columns, situated along a lake-land transect, was the reconstruction of the genesis of the layers. The columns lie in the western part of the excavation. They come from 6 houses and 5 locations between houses. In total, 7.3 litres of cultural layer sediment was analysed, 0.6 litres per column (Brombacher & Hadorn 2004). In the columns, not only remains of the lakeshore vegetation were recorded but also the economically important plants. Therefore, it was possible to compare the data from the profile columns, on the one hand, with those of the surface samples, on the other.

The frequencies (ubiquities) and densities (items per litre) of the large-seeded taxa show huge differences between the sample types, as expected (see var. figures in Jacomet [c]). The densities of hazelnut shells, beech-fruits, sloe, apple remains (pericarps and seeds) and acorns are much lower in the small samples from the profile columns than in the large surface samples. Rose-kernels show a similar trend, and apple-stalks were not found at all in the profile samples. The ubiquities also show differences: for some of the species mentioned they are much higher in the large bulk surface samples (e.g. sloe). The differences are smaller or non-existent for the very common taxa and remains in Arbon Bleiche 3 (hazelnuts and apple remains).

If one looks at the smaller taxa, the differences in the densities are as large as in the case of the large-seeded taxa. Also these remains seem to be under-represented in the profile samples (for example, naked wheat rachis remains occur at 2.2 versus 48.1 pieces per litre on average!). Densities based on profile columns only, therefore, seem to be unreliable.

If we look at the ubiquities of the smaller remains, we can recognise two groups: no or only very small differences are evident for the remains of flax, poppy seeds, seeds of *Brassica rapa* and also different berry kernels (like *Rubus*, *Fragaria*). Large differences are evident for the cereal re-

mains (e.g. *Hordeum*, all remain types together: 25% in profiles to 70% in surface samples).
How can these differences be explained? The variation in the densities shows that the remains are not evenly distributed across the settlement. Their real value is therefore not detectable with only a few broadly spaced samples. That this is really the case is demonstrated by the few sites where the results are based on a systematic surface sampling (see 4.3.1). The differences in the ubiquities allow some more conclusions: there are taxa which were present almost everywhere in site, as remains of rubbish, excrement etc., but in very different amounts (see densities). The probability of recording also locations with higher densities is lower when only a few samples are analysed. Therefore, the densities are lower in the profile columns. Other taxa like the large-seeded species and also the cereals were obviously not present everywhere in the site; therefore, the ubiquity values of surface samples and profiles are very different. Mainly the carbonised cereals tend to be concentrated in certain parts of the houses. It could be shown at Horgen Scheller or Concise Sous Colachoz that carbonised cereal remains are found in larger amounts only in hearth structures inside the houses (Favre 2002, 165; Märkle 2000, 75). Higher values in the surface samples at Arbon Bleiche 3 are associated with zones covering houses.
To conclude: the density values of only a few samples are not useful for the judgment of the importance of a taxon. In contrast, the ubiquity of many small-seeded species can more or less be estimated with relatively few (but at least 10) and small (0,5 to 1 litre) samples that are evenly distributed across the excavation surface. However, this is only the case for species that are really present in large numbers. This, however, is not known *a priori*. Therefore, counts based only on a few samples are questionable, above all when little or nothing is known about the economy of a time period. When this background knowledge is good, an assessment of the spectra of a few samples is more possible. However, even in that case the data can be «aberrant» because a settlement could be specialised in an activity like flax growing, or perhaps only one house is excavated that does not reflect the «normal mean values».
What is the minimal number of samples for estimating «real» density values? At Arbon Bleiche 3 we tested this with the help of statistical methods (rarefaction analyses; Hosch & Jacomet 2001). It turned out that with 8 evenly distributed samples, the useful plants of a house could be recorded in a representative way. If we investigate several houses (with a minimum of 8 samples per house), our values should be more or less representative.

4.4.3. Sieving problems

The comparison of different sieving techniques during the Arbon Bleiche 3 project showed for the first time at a Neolithic lakeshore settlement that sieving can have a serious influence on the presence of some remains. If the sieving is not done in a proper way, fragile remains like uncarbonised cereal chaff or apple seeds tend to be destroyed (Hosch & Zibulski 2003). A suitable sieving method was described already in the 1980s as *wash-over* by Kenward et al. 1980. During the procedure, small amounts of sediment are placed in a bowl that is held above the uppermost sieve. With the help of water, the sediment in the vessel is swirled around and the liquid portion poured into the sieve. The inorganic material remains in the bowl.
How should strongly compacted organic materials be dealt with? If the whole sediment is compacted, one should pre-treat it, for instance by freezing and subsequent slow thawing (Vandorpe & Jacomet [a]). If only some parts of the sample consist of strongly compacted remains, these may be ruminant dung. Whereas dung of small ruminants (sheep, goat) is easily recognisable (see e.g. Akeret et al. 1999), larger pieces of such compacted remains can derive from cattle dung (Kühn & Hadorn 2004). Such pieces should remain intact for a special investigation.
To conclude: if we wish to record fragile plant remains and for instance fish-scales, the *wash-over* method has to be applied, including coarse-sieving programmes during excavation. Quantification of the remains from excavations where the sieving procedure is not exactly known and where, in addition, the sieving was done by different people seem not to be very reliable. In such a case, we cannot tell whether or not some plant remains are rare because they were mostly destroyed during the sieving process.

5. Conclusions – Future prospects

5.1. Chronological developments – differences between settlements

The methodological overview shows that really reliable insights in the economy of Neolithic lakeshore villages are rare (category 1 sites in table 1; chapters 4.2 and 4.3). Of 42 more sites, the results are partly interpretable (categories 2, 3 and 4 places on table 1). The investigations of the remaining 39 settlements are not representative: they allow some indications of the presence of useful plants, when some information already exists from the same time horizon. The counts however, cannot be interpreted.
Information about the earliest phases of the Lake Dwelling area is very scarce (Early Late Neolithic; frühes Jungneolithikum; before 4000 BC). On the one hand, there are only very few lakeshore sites known from this time period (3); on the other hand, none of these sites is really well investigated or there are some other problems (Table 1). Therefore, from a scientific point of view, it is necessary to consider a thorough archaeobotanical investigation

when such a site will be excavated. This will hopefully be the case when the excavations continue at the site of Cham Eslen at Lake Zug, which was detected in 1998 (Gross-Klee & Hochuli 2002, 70–71). An evaluation of 16 samples from a first small sondage excavation (50 m^2) in the winter of 1998/1999 showed that the organic material there is very well preserved (Martinoli & Jacomet 2002, 76–77).

The state of research is much better as regards Late Neolithic settlements between 4000 – 3500 BC, although only in Central Switzerland and regions more to the east including Lake Constance, Federsee /Upper Swabia. From this region, several sites of the categories 1–4 exist (Table 1). Settlements of the Pfyn culture and related groups are well represented. In contrast, the state of research in the western part of the area considered here is not so good; only 4 settlements of the Cortaillod culture are investigated in a more or less interpretable way (categories 3 resp. 4, table 1). Here it is really necessary to do some truly reliable investigations.

Very similar is the situation for the later phases of the Late Neolithic (Spätneolithikum; 3500–2750 BC). Some sites of the Horgen culture and related groups are rather well investigated in the eastern part of area, whereas the state of the research in the western part is in comparison not so good. There are, however, at least 3 settlements of the categories 1 and 2 in the western part of the area (Table 1).

The final phase of the Lakeshore Neolithic (2750–2400 BC) is also not very well known, and there is no settlement to be classified as a category 1 site (table 1). Only from the Zurich region more or less reliable data from 4 villages of the Corded Ware culture exist. There is at least one site of the final Neolithic from western Switzerland, St. Blaise Bains des Dames, which gives good insights in the plant economy.

Reliable comparisons of the plant economy at different villages are only rarely possible. It would be for example of great interest to compare the economy of identically dated places in a region in order to reconstruct village networks, specialisations of villages or outposts etc. (see e.g. the discussion in the chapter «Synthese» of the site Horgen-Scheller in Eberli et al. 2002b, 207–212). To a certain degree this is possible only for 6 Horgen culture villages in the Zurich region, all dated to the end of the 32nd and the 31st cent. BC. They are situated at Lake Pfäffikon and different parts of Lake Zürich (Table 1).

Comparisons of villages within a wider region are also rarely possible. There are some possibilities for comparing 6–8 villages of the 40th and 39th resp. 38th and 37th cent. BC in the regions Central Switzerland – Lake Constance – Federsee/Upper Swabia. The younger group can also be compared with three settlements in the western part of the area. Similar possibilities exist in the time span between the 33rd and 30th cent. BC (Table 1); here, however, only one reliably investigated place is situated in the western part of the area.

This overview shows that it is very problematic to compare the plant economy of the eastern parts of the area considered here with the western part including the French Jura. The state of research in the western part of the area is not adequate. For demonstrating chronological developments, only the eastern part of the area is suitable. Existing hypotheses – concerning both chronological developments in the western part and comparisons between west and east - have to be tested by further research.

5.2. Prerequisites for valuable results: adequate sampling, evaluation of the archaeological record

As shown above, the first prerequisite for obtaining valuable results is a good sampling strategy. The sampling strategy must take into consideration the visibility of the strata (the settlement phases) during excavation and needs to be adapted according the existing situation. If the visible organic layers are thick, without visible internal stratigraphy, the sampling must be different from rather thin layers, which are the remains of very short-term activities. When there is enough time for a detailed excavation, the sampling can be much more intensive than in the case of a very short-term rescue excavation. In any case: one should always aim at systematic surface sampling. This can be achieved in two different ways:

The *first possibility* is to fill bags or buckets of sediment during the excavation of a layer (surface samples). If there are burnt layers with e.g. carbonised cereal ears, one should be carefully not to destroy these very fragile items. In any case, it is better to take as one sample material from all parts of a square meter (or a smaller grid size) instead of taking a single block of sediment. Surface samples can have different volumes but should not be less than 1 litre. In any case, larger volumes are better (see below). A surface sampling strategy should be applied in the following situations:

a) when a cultural layer has a very simple structure, representing most probably a single-phase settlement. Here, a surface sampling is also possible when there is no detailed excavation (see e.g. Arbon Bleiche 3, Jacomet & Leuzinger 2004).

b) if there are thicker layers of more complex stratigraphies, a systematic surface sampling only makes sense when a detailed excavation is carried out and the single layers can be differentiated properly (e.g. in the cases of St. Blaise NE Bains des Dames or Concise VD Sous Colachoz, see 4.2.).

It is very important not to have gaps in the sampled surface, because this always causes problems at the evaluation stage (Jacomet [c], fig. 10). Even when later on one decides to investigate only a part of the excavated surface (for whatever reason), a selection is only possible when the whole surface was sampled in the same systematic way.

If it is envisaged to apply a systematic surface sampling with large bulk samples for recording properly also large-seeded taxa, cereal ears, twigs, dung, remains of small animals etc. (and small archaeological artefacts like beads) the effort required is really huge. In this case, the volume of the samples should not be less than 10 litres. Because this large volume is only necessary for the larger items, we suggest taking a 1 litre subsample (e.g. with a grid system) for the recording of the smaller items. Then it is possible to sieve the larger part of the sample only with a coarse (e.g. 2 mm) sieve, what saves lots of time. Only the smaller samples will be sieved with smaller mesh sizes (down to a minimum of 0,25 mm; for the recording of economically important taxa 0,5 mm is small enough), because they contain more than enough small items (see above).

A surface sampling with large bulk samples entails large amounts of material: their transport and storage may cause problems. Wet sediments with subfossil (uncarbonised) plant remains should be stored under cool (if possible under 5 °C) and dark conditions. In such a case, it would be easier to sieve the sediments on-site with the above described wash-over-method (Hosch & Zibulski 2003). In addition, it would be very advantageous to do at least an initial semi-quantitative scanning of the coarse fraction during the excavation. This can make it possible to define the most interesting parts of the excavation for a later evaluation, and/or to identify which of the smaller subsamples should be investigated (usually much more time-consuming). The storage of the smaller subsamples does not cause large problems.

If a systematic surface sampling of the whole excavation is not possible, a second-choice strategy would be to concentrate on a part of the excavation surface (the best preserved part, one house, hearth structures etc.).

The *second possibility* is to sample the layer(s) with a dense network of profile columns (see the tube programmes mentioned above; Fig. 3). This makes sense above all when there are thick organic layers without visible internal stratigraphy or other «complicated» situations. In this case, the sample volumes will not be very large; therefore large-seeded items (and also small animal remains) will probably be underrepresented. However, this disadvantage in compensated for by dense sampling. But also here some larger bulk samples should be taken, because only then one has the possibility to investigate e.g. dung remains which are not always visible on the excavation. For being able to make some interpretations about intra-site patterns, it is necessary to take at least 2 tubes per square-meter (or even 4). One possibility is to put the tubes into the ground before the layers are excavated (e.g. in the cases of Arbon TG Bleiche 3 or Hornstaad Hörnle IA and on Fig. 3). If this is not possible, like e.g. in the zone of hearth structures, one can take columns from a section (e.g. with aluminium-boxes or flower-boxes). If an excavation is carried out with the help of the metre-strip method, the columns can be taken every meter from the profile walls. The diameter of tubes or other types of columns should be as large as possible (min. 10, or better yet 15 or more cm).

Sampling with the help of columns has an additional advantage: the stratigraphy is documented as a whole. This opens up the possibility of taking very detailed samples in order to reconstruct the genesis of the layers (see 4.1). The latter is a very important prerequisite for being able to judge the meaning of surface samples. It is known that the composition of the cultural layers is very patchy (see e.g. the evaluations of Arbon Bleiche 3; Jacomet, Leuzinger & Schibler 2004a, chap. II). Horizontal differences can be due to human activities, but also to lake level fluctuations, erosion from the landward side etc. One has to consider this when evaluating the floral spectra. Therefore, even when the sampling strategy is based on surface sampling, it is always necessary to take at least some profile columns along a lake-land transect.

With the help of systematically collected samples (surface samples or profile columns), most probably different situations are recorded: in the case of the organic layers (in German also *Detritus* or *Mist*, or in French *fumier lacustre*), mostly items are recorded which were deposited over a longer time period, more or less continuously. How long the time span is has to be evaluated thoroughly (see the evaluation of the layer of Arbon Bleiche 3 in Jacomet, Leuzinger & Schibler 2004b). Usually, a mixture of rubbish, excrement of humans and animals, remains of the local vegetation, remains of stores and insulation materials, remains of basketry etc. is preserved. All these materials were brought in by the activities of man and livestock from different parts of the environment of the settlement. In the palaeoecological sense this is a Thanatocoenosis (Willerding 1991).

The situation is very different when – as in the case of Hornstaad Hörnle IA – a burnt layer with carbonised parts of the buildings, stores of cultivated plants etc. is excavated. This represents a very short-term event (hours to 2 days approximately).

Very useful and precise insights into agricultural activities, nutrition of humans and livestock, building techniques etc. were provided by judgment samples (see 4.3.2, mainly results from Hornstaad Hörnle IA). Such samples can provide a lot of information even when there are only a few, as the example of Port BE Stüdeli has shown (Brombacher & Jacomet 2003). Therefore, it is always necessary to collect as consistently as possible all visible concentrations of plant remains, animal dung, human excrement, moss polsters, twigs, leafs etc.; these are so called closed assemblages (geschlossene Fundcomplexe) *sensu* Jacomet et al. (1989). When systematic sampling is not possible,

one should at least collect such judgment samples. However, they do not usually give good insights about that what was deposited on average over a longer time period. Therefore, ideally one should whenever possible combine systematic and judgment sampling (see the example of Hornstaad Hörnle IA; Maier 2001).
In order to evaluate archaeobotanical material in such a way that it becomes possible to reconstruct intra-site patterns, an interdisciplinary approach is needed. A close collaboration with the archaeologists is necessary in order to obtain information about the location of buildings or dating of the settlement phases. Depending on the situation, it may not be sensible to begin with archaeobotanical work before at least minimal information about the dating and the features is available. There may be exceptions when an archaeobotanical evaluation is focused on special questions like for example the morphology of cereal remains or a special investigation of animal dung etc.

5.4 Possibilities for rationalisation

The representative archaeobotanical investigation of a Neolithic lakeshore village, with a full-quantitative recording of several hundred samples, is very time consuming. At most of the settlements classified into categories 1 or 2 (Table 1), large amounts of samples were taken of which only a small part could be analysed. This is, on the one hand, due to the fact that one made deliberate selections of samples because of special research questions; on the other hand, one gets the impression (and the author's own experience shows this clearly!) that the expenditure needed for the analysis was underestimated considerably. Mermod (2000, 99) made a very informative count of the amounts of plant remains which came to the light during a coarse sieving program on excavation. The example is the final Neolithic site St. Blaise NE Bains des Dames. There, from one sector of the excavation (Nr. 160, 20m^2), 21'000 large plant remains (5 mm-sieve) were recovered. If one multiplies this number with the other 20 sectors of the excavation that were excavated in a detailed way, then 420'000 remains should be expected. For the whole excavation surface, at least 800'000 remains can be estimated. Dealing with such a number is only possible when enough «manpower» (finances) is available. This has to be considered in advance. Because the 'ideal' solution in reality almost never is possible, from the beginning onwards some rationalising measures have to be envisaged. These should bring a maximal scientific output with a minimal expenditure. Experience with some of these measures has produced some recommendations:

a) Counting (fully quantitative) only a defined number of remains per sample (after van der Veen & Fieller 1982, as in the case of Arbon Bleiche 3; Hosch & Jacomet 2004; numbers see above; for the definition of counting units see Hosch & Jacomet 2004). In this way, it is possible to record taxa which are important (have a proportion of min. 10%). If one wants to record also the rare taxa, one can scan the other parts of the fractions only for rare items. This one should be done above all for a selection of especially important samples.

b) Only semi-quantitative recording of the most important taxa/items. In the case of Neolithic lakeshore settlements these are e.g. berry kernels, apple remains (above all pericarp) or cereal bran, perhaps also cereal rachis remains and glumes, flax seeds and capsule fragments, opium poppy seeds. A semi-quantitative scale still has to be developed for Neolithic lakeshore settlements. With an adequate scale, it would even be possible to make some density calculations. Calculations of ubiquities would be possible with semi-quantitative data. There are only a very few examples of the use of such a method at Swiss sites. Author's own research (IPNA, Universität Basel; P. Vandorpe, S. Jacomet) at a Roman site with waterlogged preservation shows that semi-quantitative scanning provides very reliable results. Also, with such a method very interesting samples could be scanned for rare taxa.

c) Only 'rapid scanning' with a very simple scale (e.g. rare, moderate, many). In that way, counts of the ubiquities would be possible, but variations on the surface would be only possible in a very imprecise way. Such a procedure is in our opinion only useful for getting a first rough idea of which economically important plants are present.

d) Investigation of only a small part of the excavated area (e.g. 1 house of 5).

In the course of a 3-year PhD, fully quantitative analysis of around 70–80 large samples is possible. An experienced person could do perhaps 100 or a bit more. A scientific evaluation is included. This is, however, only the case if one does not consider finer than 0.35 mm fractions, which is not necessary for economic interpretation. In order to address questions surrounding the genesis of layers, it is necessary to consider the aquatic plant remains in even smaller sieve fractions. Experience with the proposed method b) do not exist in the lake-dwelling area, but we think this would be a reliable method for screening more samples in a shorter time. However, this is a method only experienced scientists can perform.

5.5. Suggestions for future projects

The results presented in chapter 4.2 show that only large-scale excavations with a systematic surface sampling allow reliable insight into the economy of settlements. It is desirable, therefore, that some well investigated settlements exist from all time periods and regions. This goal has yet to be reached. Only with the help of such well investigated settlements it is possible to judge to some degree the results of small-scale excavations or places where the sampling was not comprehensive. And even the meaning of single samples can be judged with greater confidence.

It is important to choose settlements carefully for such time-consuming research. Sites like Hornstaad Hörnle IA or Arbon Bleiche 3, which were settled only a short time and therefore have simple stratigraphies, should have first priority. Of course sites with complex stratigraphies are also suitable, but the sampling should be done carefully according to the stratigraphy. In the latter case, often the evaluation and the fine-correlation of the layers cause problems. Therefore, it is not surprising that among the well investigated sites of category 1 (Table 1), the villages represented are those which were inhabited for only a few years. The chronology and geography should also play a very important role when choosing sites: time periods and locations badly represented until now should have first priority (see 5.1).

Until now, the main interest of archaeobotanical research has been focused on plant macroremains like above all seeds and fruits and items like cereal chaff. Already much more rare are modern evaluations of wood remains including charcoal (e.g. Favre & Jacomet 1998; Dufraisse 2002; Zibulski 2004). All these remains allow a lot of information about the economy and environment of the settlements, but only a part of the whole is represented by them. The vegetative remains of plants that were e.g. important foodstuffs are almost never represented by macroremains. A good example is for instance ramson (*Allium ursinum*), of which seeds are almost never found but very large amounts of pollen have been documented (see already Heitz-Weniger 1978, more recently Hadorn 1994, Brombacher & Hadorn 2004). This is due to the fact that the leaves of this plant (together with some buds) were collected in early spring. Therefore, the likelihood that seeds will get into the settlements is very restricted. In the future, investigations of the microfossils should be included regularly in archaeobotanical investigations of lakeshore settlements and evaluated together with the macroremains. Both bring very good and new complementary information about foodstuffs and the use of the environment.

There are up till now also only a very few investigations of animal dung (mainly deriving from ruminants like cattle, goat and sheep; for an overview of the state of research see Kühn & Hadorn 2004; Haas 2004). Most of the investigations were carried out on the more easily recognisable dung of small ruminants, and mostly these were analyses of microremains. In Arbon Bleiche 3 we investigated for the first time many dung pieces of different origin using a multidisciplinary approach (plant macro- and microremains, insects, parasites, aDNA, micromorphology). The results are very promising. However, we did not manage to prove with 100% certainty the existence of cattle dung, even when this is more than very probable. More systematic analyses of that type therefore are urgently needed. Perhaps then it will become possible to shed some more light on all the unconfirmed findings of stables or pens (see the discussion to this topic in Ebersbach 2002, 41–46).

Up till now, there have been too few investigations of judgment samples. For example, human coprolites are of great interest, not only in terms of plant remains but also parasites. The evaluation of harvests with associated weeds also needs to be investigated further. Of some interest also is the analysis of 'crusts' inside pots; here not only plant remains but also the chemical composition allows many insights into the cooked dishes (Martínez Straumann 2004; Spangenberg 2004). We must also stress that research into the remains of small animals like fish, amphibians, birds etc. is not very developed for the Neolithic lakeshore settlements (for the state of research see Hüster Plogmann 2004).

The taking of samples is often regarded as inconvenient and tiresome. However, only the remains in such samples can shed direct light on the life of our ancestors, which brings often much deeper insights than the analysis of artefacts. The latter become often only interpretable when we understand as precisely as possible both the effort people made in order to survive and the environment in which they lived. To conclude, it must be stressed that only interdisciplinary studies really reveal relevant insights into the life of our ancestors. The example of Arbon Bleiche 3 demonstrates at least some of the possibilities.

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Bibliography

Achour-Uster C., Eberli U., Ebersbach R. & Favre P. (eds) (2002). *Die Seeufersiedlungen in Horgen. Die neolithischen und bronzezeitlichen Fundstellen Dampfschiffsteg und Scheller.* Monographien der Kantonsarchäologie Zürich 36. (Zürich / Egg).

Akeret Ö. & Geith-Chauvière I. (2003). *Les macrorestes végétaux*. In: Wüthrich S. (ed.) Saint-Aubin/Derrière la Croix. Un complexe mégalithique durant le Néolithique moyen et final. Archéologie Neuchâteloise 29, 281–293. (Neuchâtel).

Akeret Ö., Haas J. N., Leuzinger U. & Jacomet S. (1999). *Plant macrofossils and pollen in goat/sheep faeces from the Neolithic lake-shore settlement Arbon-Bleiche 3, Switzerland.* The Holocene 9 (2), 175-182.

Akeret O. & Rentzel P. (2001). *Micromorphology and plant macrofossil analysis of cattle dung from the Neolithic lake shore settlement of Arbon-Bleiche 3*. Geoarchaeology 16, 687–700.

Ammann B., Bollinger T., Jacomet S., Liese-Kleiber H. & Piening U. (1981). *Botanische Untersuchungen*. Die neolithischen Ufersiedlungen von Twann 14. (Bern).

Baudais D., Grudler A. & Lundström-Baudais K. (1997). *Les paléosemeces di niveau VIII et leur répartition spatiale*. In: Pétrequin P. (ed.) Les sites littoraux néolithiques des Clairvaux-les-Lacs et de Chalain (Jura) III: Chalain Station 3, 3200–2900 av. J.-C., Vol. 2, 723–732. (Paris).

Billamboz A. (2004). *Dendrochronologische Untersuchungen von Ufersiedlungen im Osten der Sipplinger Bucht (Grabungen 1998–99, Schnitte 40 und 140)*. In: Köninger J. & Schlichtherle H. (eds) Siedlungen der Pfyner Kultur im Osten der Pfahlbaubucht von Sipplingen, Bodenseekreis, Band 2: Naturwissenschaftliche Untersuchungen. Hemmenhofener Skripte 4, 97–109. (Freiburg i. Br.).

Bittmann F. (2001). *Die jungneolithische Feuchtbodensiedlung Pestenacker, Lkr. Landsberg/Lech – Auswirkungen auf die Landschaft aus botanischer Sicht.* In: DFG-Graduiertenkolleg 462 «Paläoökosystemforschung und Geschichte», Beiträge zur Siedlungsarchäologie und zum Lanschaftswandel. Ergebnisse zweier Kolloquien in Regensburg, 9. – 10. Oktober 2000 und 2. – 3. November 2000. Regensburger Beiträge zur Prähistorischen Archäologie 7, 93–107. (Regensburg).

Bocquet A., Caillat R. & Lundstrom-Baudais K. (1981). *Alimentation et techniques de cuisson dans le village néolithique de Charavines - Isère*. In: Demoule J. P. & Guilaine J. (eds) Le Néolithique de la France. Hommage à G. Bailloud. Colloque international sur l'alimentation de l'homme préhistorique, 319–329. (Paris).

Bogaard A. (2004). *Neolithic Farming in Central Europe*. (London).

Bollinger T. (1994). *Samenanalytische Untersuchung der frühjungsteinzeitlichen Seeufersiedlung Egolzwil 3*. Dissertationes Botanicae 221. (Stuttgart).

Brombacher C. (1986). *Untersuchungen der botanischen Makroreste des prähistorischen Siedlungsplatzes Zürich-Mozartstrasse I (Endneolithikum bis Spätbronzezeit)*. Dissertation Universität Basel.

Brombacher C. (1997). *Archaeobotanical investigations of Late Neolithic lakeshore settlements (Lake Biel, Switzerland).* Vegetation History and Archaeobotany 6, 167–186.

Brombacher C. (2000). *Archäobotanische Untersuchungen*. In: Hafner A. & Suter P. (eds) -3400. Die Entwicklung der Bauerngesellschaften im 4. Jahrtausend v. Chr. am Bielersee aufgrund der Rettungsgrabungen von Nidau und Sutz-Lattrigen. Ufersiedlungen am Bielersee 6, 155–168. (Bern).

Brombacher C. & Hadorn P. (2004). *Untersuchungen der Pollen und Makroreste aus den Profilsäulen*. In: Jacomet, Leuzinger & Schibler 2004a.

Brombacher C. & Jacomet S. (1997). *Ackerbau, Sammelwirtschaft und Umwelt: Ergebnisse archäobotanischer Untersuchungen*. In: Schibler J., Hüster-Plogmann H., Jacomet S., Brombacher C., Gross-Klee E. & Rast-Eicher A. (eds) Ökonomie und Ökologie neolithischer und bronzezeitlicher Ufersiedlungen am Zürichsee. Ergebnisse der Ausgrabungen Mozartstrasse, Kanalisationssanierungen Seefeld, AKAD/Pressehaus und Mythenschloss in Zürich. Monographien der Kantonsarchäologie Zürich 20, 220–279. (Zürich and Egg).

Brombacher C. & Jacomet S. (2003). *Ackerbau, Sammelwirtschaft und Umwelt*. In: Zwahlen, H. (ed.) Die jungneolithische Siedlung Port-Stüdeli. Ufersiedlungen am Bielersee 7, 66–86. (Bern).

De Capitani A., Deschler-Erb S., Leuzinger U., Marti-Grädel E. & Schibler J. (2002). *Die jungsteinzeitliche Seeufersiedlung Arbon Bleiche 3. Funde*. Archäologie im Thurgau 11. (Frauenfeld).

Deschler-Erb S. & Marti-Grädel E. (2004a). *Hinweise zur Schichterhaltung aufgrund der Tierknochen*. In: Jacomet, Leuzinger & Schibler 2004a.

Deschler-Erb S. & Marti-Grädel E. (2004b). *Viehhaltung und Jagd. Ergebnisse der Untersuchung der handaufgelesenen Tierknochen*. In: Jacomet, Leuzinger & Schibler 2004a.

Deschler-Erb S., Marti-Grädel E. & Schibler, J. (2002). *Die Knochen-, Zahn- und Geweihartefakte*. In: De Capitani et al. 2002, 277–366.

Dick M. (1989). *Wirtschaft und Umwelt cortaillod- und horgenzeitlicher Seeufersiedlungen in Zürich (Schweiz). Ergebnisse samenanalytischer Untersuchungen aus der prähistorischen Station Mozartstrasse*. Dissertationes Botanicae 132. (Stuttgart).

Dieckmann B. (1985). *Die neolithischen Ufersiedlungen von Hornstaad-Hörnle am westlichen Bodensee, Grabungskampagne 1983/84*. Berichte zu den Ufer- und Moorsiedlungen Südwestdeutschlands 2. (Stuttgart).

Dieckmann B. (1990). *Zum Stand der archäologischen Untersuchungen in Hornstaad*. Berichte der Römisch-Germanischen Kommission 71, 84–109.

Dieckmann B., Maier U. & Vogt R. (2001). *Hornstaad – Zur inneren Dynamik einer jungneolithischen Dorfanlage am westlichen Bodensee. Neue Ergebnisse der Archäologie, Botanik und Bodenkunde*. In: Lippert A., Schultz M., Shennan S. & Teschler-Nicola M. (eds) Mensch und Umwelt während des Neolithikums und der Frühbronzezeit in Mitteleuropa. Ergebnisse interdisziplinärer Zusammenarbeit zwischen Archäologie, Klimatologie, Biologie und Medizin. Internationale Archäologie – Arbeitsgemeinschaft, Symposium, Tagung, Kongress 2, 29–51. (Rahden/Westf.).

Dufraisse A. (2002). *Les habitats littoraux néolithiques des lacs de Chalain et Clairvaux (Jura, France): collecte du bois de feu, gestion de l'espace forestier et impact sur le couvert arboréen entre 3700 et 2500 av. J.-C. Analyses anthracologiques*. Besançon, Thèse de doctorat, spécialité « Environnement et Archéologie », Université de Franche-Comté [Multigraphié].

Eberli U. (1998). *Fundbericht 1997: Pfäffikon ZH Burg*. Jahrbuch der Schweizerischen Gesellschaft für Ur- und Frühgeschichte 81, 262.

Eberli U., Ebersbach R., Favre P., Akeret Ö. & Eberschweiler B. (2002a). *Horgen-Scheller*. In: Achour-Uster et al. 2002, 81–229.

Eberli U., Ebersbach R. & Favre P. (2002b). *Synthese*. In: Achour-Uster et al. 2002, 207–212.

Ebersbach R. (2002). *Von Bauern und Rindern. Eine Ökosystemanalyse zur Bedeutung der Rinderhaltung in bäuerlichen Gesellschaften als Grundlage zur Modellbildung im Neolithikum*. Basler Beiträge zur Archäologie 15. (Basel).

Favre P. (2001). *Analyse pflanzlicher Grossreste aus den spätneolithischen Ufersiedlungen von Horgen-Scheller, Kanton Zürich, Schweiz. Ein Beitrag zu Umwelt- und Wirtschaftsgeschichte des 31. Jh. v. Chr. im nördlichen Alpenvorland*. Dissertation, Universität Basel.

Favre P. (2002). *Archäobotanik*. In: Achour-Uster et al. 2002, 150–180.

Favre P. & Jacomet S. (1998). *Branch wood from the lake shore settlements of Horgen Scheller, Switzerland: Evidence for economic specialisation in the late Neolithic period*. Vegetation History and Archaeobotany 7, 167–178.

Fredskild B. (1978). *Seeds and Fruits of the Neolithic Settlement Weier, Switzerland*. Botanisk Tidsskrift 72, 189–201.

Furger A. R. (1980). *Botanische Makroreste (Bestimmungen: B. Pawlik)*. In: Furger A. R. (ed.) Die Siedlungsreste der Horgener Kultur. Die neolithischen Ufersiedlungen von Twann 7, 125–131. (Bern).

Gross-Klee E. & Hochuli S. (2002). *Die jungsteinzeitliche Doppelaxt von Cham-Eslen*. Tugium 18, 69–101.

Haas J. N. (2004). *Mikroskopische Analyse von Schaf-/Ziegenkoprolithen*. In: Jacomet, Leuzinger & Schibler 2004a.

Haas J. N. & Magny M. (2004). *Sedimentations- und Vegetationsgeschichte*. In: Jacomet, Leuzinger & Schibler 2004a.

Hadorn P. (1994). *Saint-Blaise/Bains des Dames 1, Palynologie d'un site néolithique et histoire de la végétation des derniers 16000 ans*. Archéologie Neuchâteloise 18. (Neuchâtel).

Hafner A. (1998). *Archäobotanische Untersuchungen in Reute-Schorrenried*. In: Mainberger M. (ed.) Das Moordorf von Reute. Archäologische Untersuchungen in der jungneolithischen Siedlung Reute Schorrenried, 385–418. (Staufen i. Br.).

Hafner A. & Suter P. (1997). *Entwurf eines neuen Chronologie-Schemas zum Neolithikum des schweizerischen Mittellandes*. Archäologisches Korrespondenzblatt 27, 549–565.

Hafner A. & Suter P. (2000). *-3400 v. Chr. Die Entwicklung der Bauerngesellschaften im 4. Jahrtausend v. Chr. am Bielersee*. Ufersiedlungen am Bielersee 6. (Bern).

Hafner A. & Suter P. (2003). *Das Neolithikum der Schweiz*. Internet www.jungsteinSITE.de (16. 11. 2004)

Heer O. (1865). *Die Pflanzen der Pfahlbauten*. Neujahrsblatt der Naturforschenden Gesellschaft in Zürich für das Jahr 1866, 1–54.

Heitz-Weniger A. (1978). *Pollenanalytische Untersuchungen an den neolithischen und spätbronzezeitlichen Seerandsiedlungen Kleiner Hafner, Grosser Hafner und Alpenquai im untersten Zürichsee (Schweiz)*. Botanische Jb. für Systematik, Pflanzengeschichte und Pflanzengeographie 99, 48–107.

Herbig C. (2002). *Archäobotanische Untersuchungen in der spätneolithischen Moorsiedlung Torwiesen II im Federseemoor (Stadt Buchau, Kreis Biberach)*. Magisterarbeit, Johann Wolfgang Goethe Universität Frankfurt/M.

Hochuli S., Schaeren G. F. & Weiss J. (1998). *Ein Dorfbrand am Zugersee vor 5700 Jahren: ein archaeologischer Glücksfall*. Archäologie der Schweiz 21, 134–141.

Hofmann R. (1983–84). *Die vegetabilischen vor- und frühgeschichtlichen Funde aus Niederbayern und der Oberpflaz südlich der Donau im Rahmen der Siedelgeschichte. Ein Beitrag zur Aussagefähigkeit der Paläo-Ethnobotanik*. Bericht der Bayerischen Bodendenkmalpflege 24–25 [1986], 112–157.

Hopf M. (1968). *Früchte und Samen*. In: Zürn H. (ed.) Das jungsteinzeitliche Dorf Ehrenstein (Kreis Ulm). Veröffentlichungen des Staatlichen Amtes für Denkmalpflege Stuttgart, Reihe A 10/II, 7–77. (Stuttgart).

Hopf M. & Blankenhorn B. (1983–84). *Kultur- und Nutzpflanzen aus vor- und frühgeschichtlichen Grabungen Süddeutschlands*. Bericht der Bayerischen Bodendenkmalpflege 24–25 [1986], 76–111.

Hosch S. (2003). *Ackerbau und Sammelwirtschaft in der neolithischen Seeufersiedlung Arbon Bleiche 3 (3384–3370 v.Chr.) Kanton Thurgau, Schweiz*. Dissertation, Universität Basel.

Hosch S. & Jacomet S. (2001). *New aspects of archaeobotanical research in Central European Neolithic Lake Dwelling Sites*. Environmental Archaeology 6, 59–71.

Hosch S. & Jacomet S. (2004*). Ackerbau und Sammelwirtschaft. Ergebnisse der Untersuchung von Samen und Früchten*. In: Jacomet, Leuzinger & Schibler 2004a.

Hosch S. & Zibulski P. (2003). *The influence of inconsistent wet-sieving procedures on the macroremain concentration in waterlogged sediments*. Journal of Archaeological Science 30, 849–857.

Hüster Plogmann H. (1996). *Correlation between sample size and relative abundance of fish bones: examples from the excavations at Arbon/TG Bleiche 3, Switzerland*. Archaeofauna 5, 141–146.

Hüster Plogmann H. (2004). *Fischfang und Kleintierbeute. Ergebnisse der Untersuchung von Tierresten aus den Schlämmproben.* In: Jacomet, Leuzinger & Schibler 2004a.

Ismail-Meyer K. & Rentzel P. (2004). *Mikromorphologische Untersuchung der Schichtabfolge*. In: Jacomet, Leuzinger & Schibler 2004a.

Jacomet S. (1980). *Botanische Makroreste aus den neolithischen Seeufersiedlungen des Areals Pressehaus Ringier in Zürich (Schweiz). Stratigraphische und vegetationskundliche Auswertung*. Vierteljahresschrift der Naturforschenden Gesellschaft in Zürich 125, 73–163.

Jacomet S. (1981). *Neue Untersuchungen botanischer Grossreste an jungsteinzeitlichen Seeufersiedlungen im Gebiet der Stadt Zürich (Schweiz)*. Zeitschrift für Archäologie 15, 125–140.

Jacomet S. (1985). *Botanische Makroreste aus den Sedimenten des neolithischen Siedlungsplatzes AKAD-Seehofstrasse am untersten Zürichsee. Die Reste der Uferpflanzen und ihre Aussagemöglichkeiten zu Vegetationsgeschichte, Schichtentstehung und Seespiegelschwankungen*. Zürcher Studien zur Archäologie. (Zürich).

Jacomet S. (1986). *Kulturpflanzenfunde aus der neolithischen Seeufersiedlung Cham-St. Andreas (Zugersee)*. Jahrbuch der Schweizerischen Gesellschaft für Ur- und Frühgeschichte 69, 55-62.

Jacomet S. (1990*). Veränderungen von Wirtschaft und Umwelt während des Spätneolithikums im westlichen Bodenseegebiet. Ergebnisse samenanalytischer Untersuchungen an einem Profilblock aus der Horgener Schichtabfolge von Sipplingen-Osthafen (Tauchsondierung Ruoff 1980).* Siedlungsarchäologie im Alpenvorland II. Berichte zu den Ufer- und Moorsiedlungen Südwestdeutschlands. Forschungen und Berichte zu Vor- und Frühgeschichte in Baden-Württemberg 37, 295–324.

Jacomet S. (2004). *Archäobotanische Grobuntersuchung verkohlter Getreideklumpen*. In: Hügi U. & Michel-Tobler Ch. (eds) Oberrieden ZH-Riet – eine frühhorgenzeitliche Siedlung. Jahrbuch der Schweizerischen Gesellschaft für Urund Frühgeschichte 87, 21–23.

Jacomet S. ([a] in press). *Neolithic plant economies in the northern alpine foreland (Central Europe) from 5500–3500 BC cal.* In: Colledge S. & Conolly J. (eds) Archaeobotanical perspectives on the origin and spread of agriculture in southwest Asia and Europe. (London).

Jacomet S. ([b] in press). *Plant Economy in the Northern Alpine Lake Dwelling area – 3500–2400 BC cal.* In: Karg S., Baumeister R., Schlichtherle H & Robinson D. E. (eds) Economic and Environmental Changes during the 4th and 3rd Millenia BC. Proceedings of the 25th Symposium of the AEA Sept. 2004 in Bad Buchau, Germany). Environmental Archaeology.

Jacomet S. ([c] in press). *Leben wie zu «Pfahlbauer's Zeiten» – Zu Forschungsergebnissen, Methoden und zukünftigen Forschungsstrategien archäobotanischer Untersuchungen von neolithischen Seeufer- und Moorsiedlungen.* Jahrbuch der Schweizerischen Gesellschaft für Ur- und Frühgeschichte 88.

Jacomet S., Brombacher C. & Dick M. (1989). *Archäobotanik am Zürichsee. Ackerbau, Sammelwirtschaft und Umwelt von neolithischen und bronzezeitlichen Seeufersiedlungen im Raum Zürich. Ergebnisse von Untersuchungen pflanzlicher Makroreste der Jahre 1979–1988.* Zürcher Denkmalpflege, Monographien 7. (Zürich).

Jacomet S. & Kreuz A. (1999). *Archäobotanik. Aufgaben, Methoden und Ergebnisse vegetations- und agrargeschichtlicher Forschungen*. (Stuttgart).

Jacomet S. & Kreuz A. ([a] in press). *Geschichte der Archäobotanik*. In: Pichler S. & Pernicka E. (eds) Naturwissenschaften und Archäologie: Geschichte einer Wechselwirkung. Beiträge zur Archäologie und Archäometrie. (Freiberg).

Jacomet S. & Leuzinger U. (2004). *Einleitung*. In: Jacomet, Leuzinger U. & Schibler 2004.

Jacomet S., Leuzinger U. & Schibler J. (eds) (2004a). *Die jungsteinzeitliche Seeufersiedlung Arbon Bleiche 3. Umwelt und Wirtschaft*. Archäologie im Thurgau 12. (Frauenfeld).

Jacomet S., Leuzinger U., & Schibler J. (2004b). *Synthesis*. In: Jacomet, Leuzinger & Schibler 2004a.

Jacomet S. & Wagner C. (1987). *Verkohlte Pflanzenreste aus der Horgener Kulturschicht von Zug-Vorstadt 26*. Jahrbuch der Schweizerischen Gesellschaft für Ur- und Frühgeschichte 70, 175–180.

Jörgensen G. (1975). *Triticum aestivum s.l. from the Neolithic Site of Weier in Switzerland*. Folia Quaternaria 46, 7–21.

Karg S. (1990). *Pflanzliche Grossreste der jungsteinzeitlichen Ufersiedlungen von Allensbach-Strandbad. Wildpflanzen und Anbaufrüchte als stratigraphische, ökologische und wirtschaftliche Informationsquellen.* In: Siedlungsarchäologie im Alpenvorland II. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 37, 113–166. (Stuttgart).

Karg S. & Märkle T. (2002). *Continuity and changes in plant resources during the Neolithic period in western Switzerland*. Vegetation History and Archaeobotany 11, 169–176.

Kenward H. K., Hall A. R. J. & Jones A. K. C. (1980). *A tested set of techniques for the extraction of plant and animal macrofossils from waterlogged archaeological deposits*. Science and Archaeology 22, 3–15.

Kolb M. (2003). *Funde und Befunde aus den taucharchäologischen Ausgrabungen in den Schichten 7, 8 und 9 von Sipplingen-Osthafen.* In: Köninger J. & Schlichtherle H. (eds) Siedlungen der Pfyner Kultur im Osten der Pfahlbaubucht von Sipplingen, Bodenseekreis, Band 1: Funde und Befunde. Hemmenhofener Skripte 4, 9–53. (Freiburg i. Br.).

Kühn M. & Hadorn P. (2004). *Pflanzliche Makro- und Mikroreste aus Dung von Wiederkäuern*. In: Jacomet, Leuzinger & Schibler 2004a.

Küster H. (1989). *Pflanzenreste in spätneolithischen Siedlungsgeschichten von Ergolding-Fischergasse, Lkr.Landshut*. In: Schmotz K. (ed.) Vorträge des 7. Niederbayrischen Archäologentages, 17–25. (Deggendorf).

Lambert G. & Lavier C. (1997). *Datations dendrochronologiques de la station 3 de Chalain*. In: Pétrequin P. (ed.) Les sites littoraux Néolothiques de Clairvaux-les-Lacs et de Chalain (Jura) III: Chalain station 3, 3200–2900 av. J.-C., 55–64. (Paris).

Le Bailly M. & Bouchet F. (2004). *Etude paléoparasitologique des coprolithes humains*. In: Jacomet, Leuzinger & Schibler 2004a.

Lemdahl G. (2004). *Insect remains*. In: Jacomet, Leuzinger & Schibler 2004a.

Leuzinger U. (2000). *Die jungsteinzeitliche Seeufersiedlung Arbon Bleiche 3. Befunde*. Archäologie im Thurgau 9. (Frauenfeld).

Lundström-Baudais K. (1986). *Étude paléoethnobotanique de la station III de Clairvaux*. In: Pétrequin P. (ed.) Les Sites Littoraux Néolithiques de Clairvaux-Les-Lacs (Jura) I: Problématique générale, 311–404. (Paris).

Lundström-Baudais K. (1989). *Les macrorestes végétaux du niveau V de la Motte-aux-Magnins*. In: Pétrequin P. (ed.) Les sites littoraux néolithiques de Clairvaux-les-Lacs (Jura) II: Le Néolithique moyen, 417–439. (Paris).

Maier U. (1995). *Moorstratigraphische und paläobotanische Untersuchungen in der jungsteinzeitlichen Moorsiedlung Ödenahlen am Federsee*. In: Siedlungsarchäologie im Alpenvorland III – Die neolithische Moorsiedlung Ödenahlen. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 46, 143–253. (Stuttgart).

Maier U. (2001*). Archäobotanische Untersuchungen in der neolithischen Ufersiedlung Hornstaad-Hörnle IA am Bodensee*. In: Maier U. & Vogt R. (eds) Siedlungsarchäologie im Alpenvorland VI – Botanische und pedologische Untersuchungen zur Ufersiedlung Hornstaad-Hörnle IA. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 74, 9–384. (Stuttgart).

Maier U. (2004). *Archäobotanische Untersuchungen in jung- und endneolithischen Moorsiedlungen am Federsee (mit einem Beitrag von Richard Vogt)*. In: Köninger J. & Schlichtherle H. (eds) Ökonomischer und ökologischer Wandel am vorgeschichtlichen Federsee – Archäologische und naturwissenschaftliche Untersuchungen. Hemmernhofener Skripte 5, 71–159. (Gaienhofen-Hemmenhofen).

Märkle T. (2000). *Die Wildpflanzen der Cortaillod moyen-zeitlichen Besiedlung von Concise-sous-Colachoz, Kt. Waadt, Schweiz. Eine Analyse der botanischen Makroreste*. Magisterarbeit Universität Tübingen.

Marti H. (2004). *Parasitologische Untersuchungen von Wiederkäuer-Exkrementen*. In: Jacomet, Leuzinger & Schibler 2004a.

Martínez Straumann S. (2004). *Makro- und mikroskopische Untersuchungen von Speisekrusten aus Keramikgefässen*. In: Jacomet, Leuzinger & Schibler 2004a.

Martinoli D. & Jacomet S. (2002). *Pflanzenfunde aus Cham-Eslen: Erste Ergebnisse zur Versorgung mit pflanzlichen Nahrungsmitteln*. Tugium 18, 76–77.

Menotti F. (2004). *Living on the lake in prehistoric Europe. 150 years of lake-dwelling research*. (London).

Mermod O. (2000). *Die endneolithische Seeufersiedlung Saint-Blaise/Bains des Dames NE. Botanische Untersuchungen zur Vegetation, Landwirtschaft und Ernährung in der Auvernier Cordé Kultur (2640–2450BC)*. Dissertation ETH Zürich.

Neef R. (1990). *Botanische Untersuchungen im jungneolithischen Pestenacker*. Berichte der Römisch-Germanischen Kommission 71, 381–389.

Orcel A. (1980). *Partie Archéologique*. In: Ammann B., Joos M., Orcel A., Schoch W. & Schweingruber F. H. (eds) Die Profilkolonne X/42. Die neolithischen Ufersiedlungen von Twann 6, 11–44. (Bern).

Pétrequin P. (1997a). *Les sites littoraux néolithiques de Clairvaux-les-Lacs et de Chalain (Jura) III. Chalain station 3, 3200–2900 av. J.-C. 3*. (Paris).

Pétrequin P. (1997b). *Introduction: Problématique de la recherche*. In: Pétrequin P. (ed.) Les sites littoraux Néolithiques de Clairvaux-les-Lacs et de Chalain (Jura) III: Chalain station 3, 3200–2900 av. J.-C., 27–34. (Paris).

Pétrequin P. (1997c). *Stratigraphie et stratégie de la fouille*. In: Pétrequin P. (ed.) Les sites littoraux Néolithiques de Clairvaux-les-Lacs et de Chalain (Jura) III: Chalain station 3, 3200–2900 av. J.-C., 37–54. (Paris).

Piening U. (1981). *Die verkohlten Kulturpflanzenreste aus den Proben der Cortaillod- und Horgener Kultur*. In: Ammann B., Bollinger T., Jacomet S., Liese-Kleiber H. & Piening U. (eds) Die botanischen Untersuchungen. Die neolithischen Ufersiedlungen von Twann 14, 69–88. (Bern).

Riehl S. (1993). *Botanische Grossreste aus einer neolithischen Profilabfolge. Die Horgenzeitliche Seeufersiedlung Wangen / Bodensee*. Magisterarbeit, Universität Tübingen.

Riehl S. (2004). *Jungneolithische Pflanzenproduktion und Nutzung des Naturraums am Überlinger See / Bodensee. Archäobotanische Untersuchungen an Kulturschichtsedimenten aus der Seefersiedlung Sipplingen*. In: Köninger J. & Schlichtherle H. (eds) Siedlungen der Pfyner Kultur im Osten der Pfahlbaubucht von Sipplingen, Bodenseekreis, Band 2: Naturwissenschaftliche Untersuchungen. Hemmenhofener Skripte 4, 9–76. (Freiburg i. Br.).

Rösch M. (1990a). *Botanische Untersuchungen an Pfahlverzügen der endneolithischen Ufersiedlung Hornstaad-Hörnle V am Bodensee*. In: Siedlungsarchäologie im Alpenvorland II. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 37, 325–351. (Stuttgart).

Rösch M. (1990b). *Botanische Untersuchungen in spätneolithischen Ufersiedlungen von Wallhausen und Dingelsdorf am Überlinger See (Kr. Konstanz)*. In: Siedlungsarchäologie im Alpenvorland II. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 37, 227–266. (Stuttgart).

Rösch M. (1990c). *Hegne-Galgenacker am Gnadensee. Erste botanische Daten zur Schnurkeramik am Bodensee*. In: Siedlungsarchäologie im Alpenvorland II. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 37, 199–225. (Stuttgart).

Schaal C. (2000). *Etude carpologique d'un village néolithique: la station 19 de Chalain (Jura) au 30ème siècle av. J.-C.* DEA, Université de Franche Comté, Besançon.

Schibler J., Jacomet S., & Choyke A. (2004). *Neolithic Lake Dwellings in the Alpine Region*. In: Bogucki P. & Crabtree P. J. (eds) Ancient Europe 8000 B.C. – A.D. 1000. Encyclopedia of the Barbarian World. Vol. 1: The Mesolithic to Copper Age (c. 8000–2000 B.C.), 385–392. (New York).

Schlichtherle H. (1981). *Cruciferen als Nutzpflanzen in neolithischen Ufersiedlungen Südwestdeutschlands und der Schweiz*. Zeitschrift für Archäologie 15, 113–124.

Schlichtherle H. (1985). *Samen und Früchte: Konzentrationsdiagramme pflanzlicher Grossreste aus einer neolithischen Seeuferstratigraphie. Quantitative Untersuchungen an einem Profilsockel in Yverdon, Avenue des Sports*. (Freiburg i. Br.).

Schlichtherle H. (1990). *Siedlungsarchäologie im Alpenvorland I: Die Sondagen 1973–1978 in den Ufersiedlungen Hornstaad-Hörnle I*. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 36. (Stuttgart).

Schlichtherle H. (1997). *Pfahlbauten rund um die Alpen*. In: Schlichtherle H. (ed.) Pfahlbauten rund um die Alpen. Archä-

ologie in Deutschland, Sonderheft, 7–14. (Stuttgart).
Schlichtherle H. (2004). *Grosse Häuser – Kleine Häuser. Archäologische Befunde zum Siedlungswandel am neolithischen Federsee*. In: Köninger J. & Schlichtherle H. (eds) Ökonomischer und ökologischer Wandel am vorgeschichtlichen Federsee. Archäologische und naturwissenschaftliche Untersuchungen. Hemmenhofener Skripte 5, 13–56. (Gaienhofen-Hemmenhofen).
Sormaz T. (2004). *Absolute Datierung durch Dendrochronologie und ^{14}C-Analysen*. In: Jacomet, Leuzinger & Schibler 2004.
Spangenberg J. (2004). *Food residues: Chemistry*. In: Jacomet, Leuzinger & Schibler 2004.
Stöckli W. E., Niffeler U., & Gross-Klee E. (1995). *Neolithikum. Die Schweiz vom Paläolithikum bis zum frühen Mittelalter (SPM) II*. (Basel).
Thew N. (2004). *The Aquatic and Terrestrial Molluscs from the Profile Columns*. In: Jacomet, Leuzinger & Schibler 2004.
van der Veen M. & Fjeller N. R. J. (1982). *Sampling Seeds*. Journal of Archaeol. Science 9, 287–298.
Van Zeist W. & Boekschoten-van Helsdingen A. M. (1991). *Samen und Früchte aus Niederwil*. In: Waterbolk & Van Zeist W. 1991, 49–97.
Vandorpe P. & Jacomet S. ([a] submitted). *Comparing different pre-treatment methods for strongly compacted sediments prior to wet-sieving: a case study of Roman waterlogged deposits*. Environmental Archaeology.
Vandorpe, P. & Jacomet, S. ([b] submitted*). Testing subsample sizes for the analysis of waterlogged plant remains. The example of roman Biesheim-Kunheim, France*. Journal of Archaeological Science.
Villaret-von Rochow M. (1967). *Frucht- und Samenreste aus der neolithischen Station Seeberg, Burgäschisee-Süd*. In: Seeberg Burgäschisee Süd, Teil 4: Chronologie und Umwelt. Acta Berniensia II, 21–63. (Bern).
Waterbolk H. T. E. & Van Zeist W. (1991). *Niederwil, eine Siedlung der Pfyner Kultur. Band III: Naturwissenschaftliche Untersuchungen*. Academica Helvetica III 1. (Bern and Stuttgart).
Willerding U. (1991). *Präsenz, Erhaltung und Repräsentanz von Pflanzenresten in archäologischem Fundgut*. In: Van Zeist W., Wasylikowa K. & Behre K.-E. (eds) Progress in Old World Palaeoethnobotany, 25–51. (Rotterdam).
Wolf C. (1993). *Die Seeufersiedlung Yverdon, Avenue des Sports (Kanton Waadt)*. Cahiers d'Archéologie Romande 59. (Lausanne).
Wyss R. (1994). *Steinzeitliche Bauern auf der Suche nach neuen Lebensformen. Egolzwil 3 und die Egolzwiler Kultur, Bd. 1: Die Funde*. Archäologische Forschungen. (Zürich).
Wyss R. (1996). *Steinzeitliche Bauern auf der Suche nach neuen Lebensformen: Egolzwil 3 und die Egolzwiler Kultur, Bd. 2: Die Grabungsergebnisse*. Archäologische Forschungen. (Zürich).
Zibulski P. (2004). *Zweige und Knospen*. In: Jacomet, Leuzinger & Schibler 2004.